University of Alberta

Impacts of World Trade Policies on the Canadian Poultry Market

by

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CHAPTER 1

BACKGROUND AND INTRODUCTION

1.1 Introduction

The poultry market has been one of the most rapidly growing sectors of the food industry over the past two decades. World poultry production has increased from 53,591 million tons in 1997 to over 61,357 million tons in 2001. The total value of poultry trade has increased along with this increase in production. Consumption of poultry in the world has overtaken that of red meat, which is possibly due to consumer health concerns and the relative prices of various meats. The international poultry trade is becoming an increasingly important issue.

The international poultry meat market is affected by policies of different kinds in various countries. Both the U.S. and the EU subsidize the export of poultry products through different schemes. Canada has supply management systems and export policies for chicken and turkey that have increasingly accommodated exports over the latter part of the 1990's. However, future growth in poultry exports from Canada may be directly affected by agreements produced in the next round of multinational trade talks. The implications of subsidies provided by other countries on potential exports from Canada have never been quantified. In addition, it is likely that the structural evolution of the Canadian poultry processing sector has been affected by the existence of supply management practices, particularly with respect to vertical integration in the industry as compared to the U.S. The purpose of this study is to investigate if the trade policies of other competitive countries affect Canadian poultry trade. Ultimately, given the recent trade dispute in dairy products, the industry may have to decide whether to export or to

maintain supply management. It is useful to understand the importance of trade to the welfare of producers and processors in Canada and what impacts Canadian exports are having on world markets.

1.2 Overview of Canadian Poultry Sector

1.2.1 Disappearance of Domestic Meat

In 2003, preliminary information indicates a slight increase in Canadian meat consumption of 1.5 kilograms per capita when compared to 2002 levels. Chicken became the most consumed meat product in Canada in 1996 and represented 35.9% of all meat consumed. Beef and pork consumption have declined consistently during the period 1996-2003.

Table 1.1 Canadian Meats per Capital Consumption during 1996-2003 (Carcass Weight kg)

	1996	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*
Chicken	26.6	27.5	28.2	29.6	30.9	32.0	31.6	31.7
Turkey	4.1	4.2	4.3	4.2	4.3	4.2	4.3	4.3
Beef	22.9	22.9	23.3	23.8	22.9	22.3	21.9	23.1
Pork	19.7	19.3	20.6	21.4	21.7	22.0	21.4	21.6
Lamb	0.8	0.7	0.8	0.8	0.9	1.0	1.0	1.0
Total	74.1	74.6	77.2	79.8	80.7	81.5	80.2	81.7
Chicken %	35.9%	36.9%	36.5%	37.1%	38.3%	39.3%	39.4%	38.8%
Turkey %	5.5%	5.6%	5.5%	5.2%	5.3%	5.1%	5.3%	5.2%

(Source: USDA[1], Foreign Agricultural Service Gain Report, 1995-2003; FAO[2] Statistical Database, 2002)

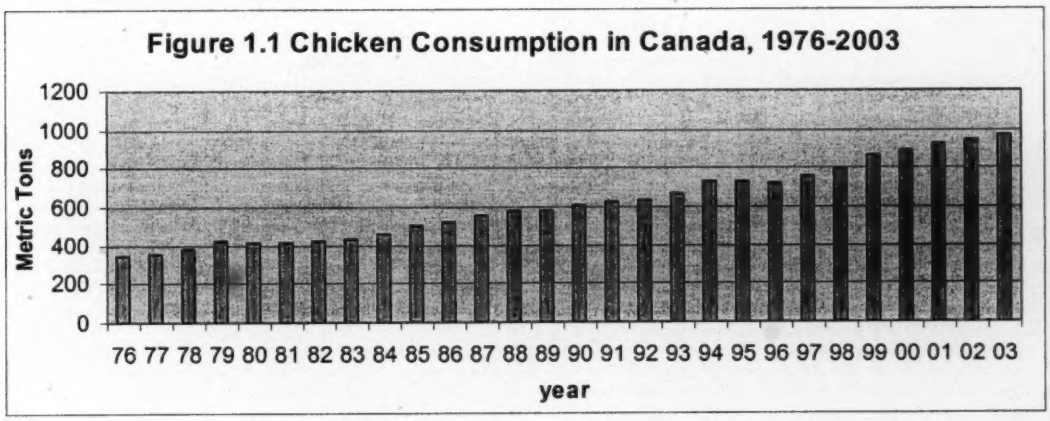
1.2.2 Chicken

1) Domestic Consumption

Demand for chicken has increased substantially in Canada in the 1990's. In 1989, total domestic consumption was 539 million kilograms, compared with 927 million

[1] U.S. Department of Agriculture
[2] Food and Agriculture Organization of the United Nations

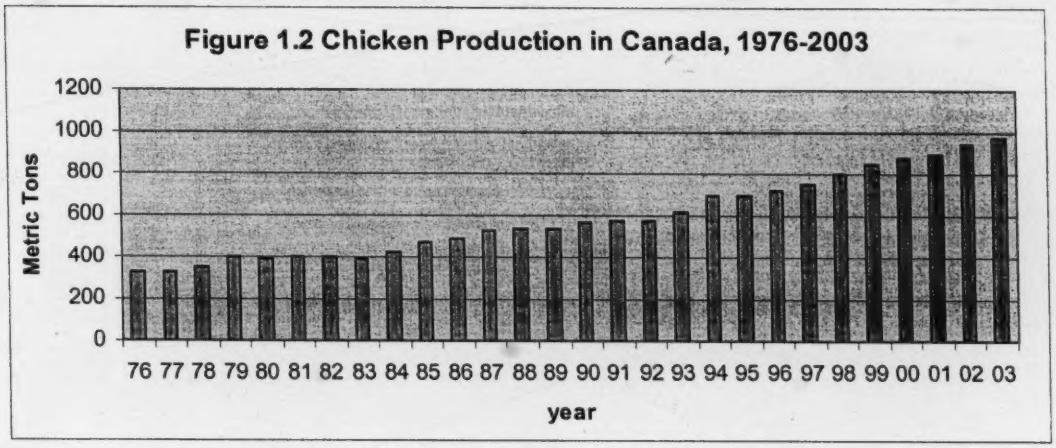
kilograms in 2003. Canadian producers supplied 92.7% of the market in 2003, with the balance being imported. While the majority of chicken is still sold in retail stores (58.4% in 2003), the proportion of chicken consumed away from home continues to increase. Full-service restaurants have been the primary beneficiaries of this increase, as their share of domestic demand has increased from 8.4% in 1992 to 12% in 2000 *(Agriculture and Agri-Food Canada, 2001)*. The per capita consumption of chicken in 2003 was 31.7 kg, an increase of 90% since 1976.



(Source: USDA, Production, Supply, and Distribution Database, 2003)

2) Production

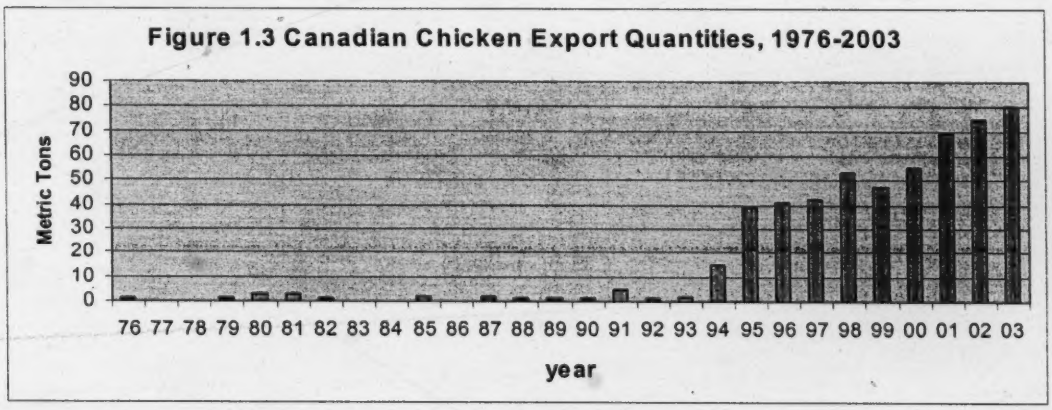
Canadian chicken production has increased over the past ten years. Under the supply management system, the level of production of poultry meat is largely dictated by domestic consumption. Figure 1.2 shows total chicken production in Canada from 1976 to 2003. Production increased from 329 million kilograms in 1976 to 960 million kilograms in 2003.



(Source: USDA, Production, Supply, and Distribution Database, 2003)

3) Exports

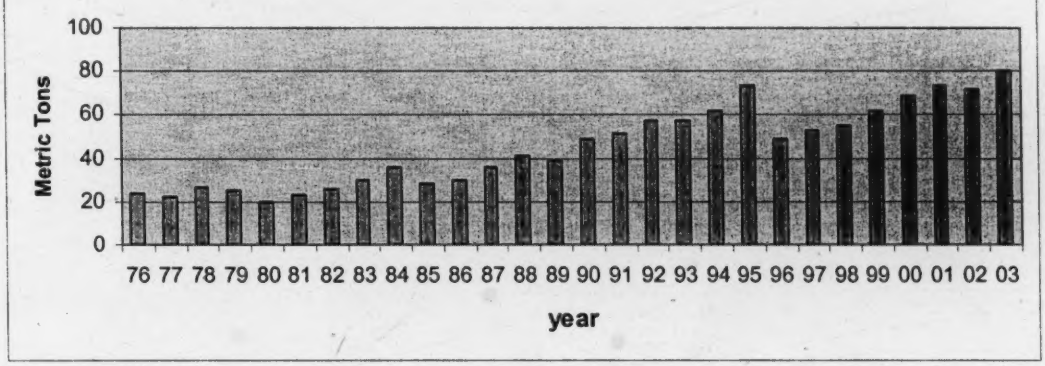
Over the past twenty-five years, Canadian chicken exports have become much more important to the industry. Prior to 1994, chicken exports represented less than one percent of domestic production. Since then, changes to the production quota allocation system facilitated Canada to increase chicken exports, and as a result the amount of chicken exported has risen significantly (Figure 1.3), but is still small relative to production, domestic consumption.



(Source: USDA, Production, Supply, and Distribution Database, 2003)

In 1994, the Chicken Farmers of Canada (CFC) approved a national export policy, the first for the industry's exports. The policy, developed in close cooperation with industry stakeholders, provides processors with the means to take advantage of planned exports, while ensuring that they do not disrupt the domestic market. In March 1997, the CFC implemented a national export policy framework within which provinces can manage programs effectively for the export markets. The newest version of this export policy will be explained in Chapter 2. By 2003, chicken meat exports grew to 80,464 tons, an increase of 535% when compared to the 1994 level. In 2003, exports represented 8% of Canada's total production. Currently, Canada ranks the eighth worldwide in the volume of exported chicken.

Figure 1.4 Canadian Chicken Import Quantities, 1976-2003



(Source: USDA, Production, Supply, and Distribution Database, 2003)

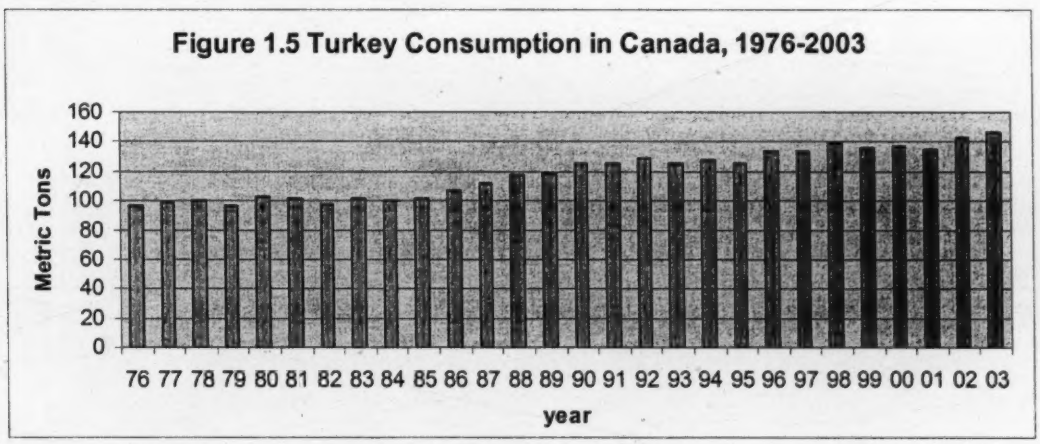
4) Imports

The United States is virtually the sole supplier of chicken to Canada. Under the FTA/NAFTA agreement, U.S. access to Canada's chicken market is based on 7.5% of Canada's production of chicken in previous years. Historically, U.S. exports have

constituted virtually all of Canadian imports and exceeded minimum import quota levels due to the issuance of supplemental import quotas. In 1995, Canada replaced its import quota on chicken by a tariff rate quota regime based on the Uruguay Round Commitments. Within quota tariff rates declined by 57% between 1995 and 2000 with the exception of products of U.S. origin where the within-quota tariff rates were completely eliminated on January 1st, 1998. The tariffs applicable to over-access rate imports declined by 15% between 1995 and 2000 *(Agriculture and Agri-Food Canada, 2001).*

1.2.3 Turkey

1) Domestic Consumption



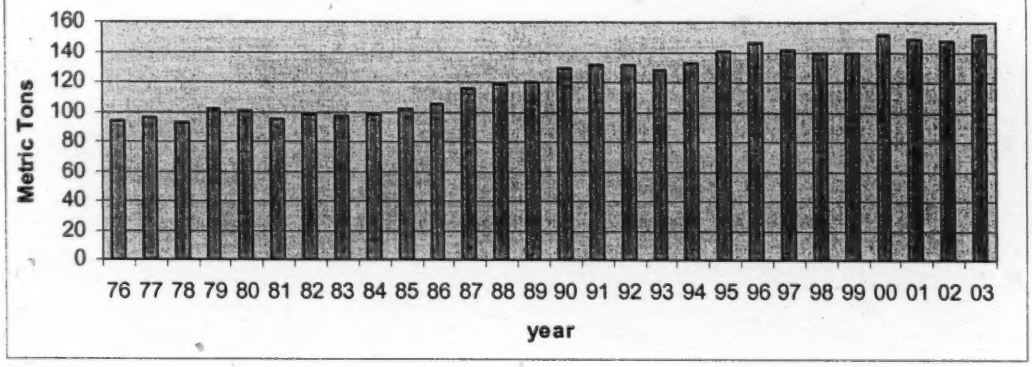
(Source: USDA, Production, Supply, and Distribution Database, 2003)

Demand for turkey has also increased in Canada during the past decade. In 1989, total domestic consumption was 120 million kilograms compared to 146 million kilograms in 2003. Canadian producers supplied 96% of the domestic market in 2003. Canada has a positive balance of trade in turkey, with exports totaling 15 million

kilograms in 2003, with only 6 million kilograms imported. The per capita consumption of turkey in 2003 was 4.3 kilograms, a decrease of 5% from 1993. Turkey represents just 5.26% of Canada's total meat consumption. In Canada, and in some western countries, turkey demand continues to be primarily seasonal, with most consumption occurring during Christmas and Thanksgiving *(Agriculture and Agri-Food Canada and Market and Industry Services Branch, 1999).*

2) Production

Figure 1.6 Turkey Production in Canada, 1976-2003



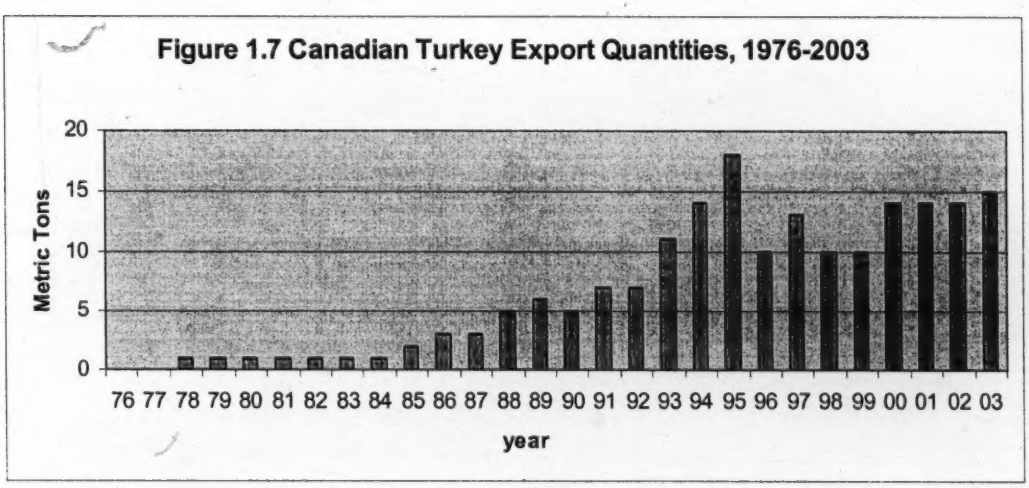
(Source: USDA, Production, Supply, and Distribution Database, 2003)

Figure 1.6 shows that the growth of Canadian turkey production was not consistent over the period 1976 to 2001. Between 1996 and 1999 there was a small decline. During the period between 2000 and 2003, there was an increase in Canadian turkey production due to increased domestic demand and growing exports.

3) Exports

Canada is a net exporter of turkey products. Since the mid-1980s, the provincial turkey producers and processors have worked together to develop business arrangements

that would permit turkey to be grown and processed specifically for the export market. These co-operative arrangements, in which the Canadian Turkey Marketing Agency has a coordinating role, have played an important part in the steady growth of export product sales and in sustaining production levels in a domestic market that has remained stagnant. In 1994, a new turkey export policy was approved. This policy helped Canada to increase its turkey exports from 11,145 tons in 1993 to 15,000 tons in 2003 (Figure 1.7). The average annual growth rate during 1994 to 2003 years was 11%. The quantity of exports in 1996 fell by about 10% from 1995 due to the Asian economic crisis at that time. From 1996-1999, Canadian turkey exports stayed at the same level because the Asian and Russian economies did not improve.

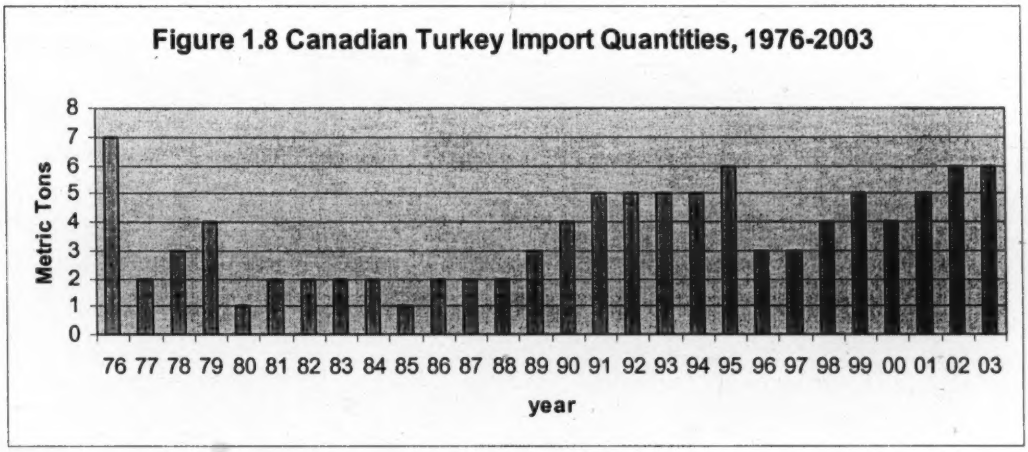


(Source: USDA, Production, Supply, and Distribution Database, 2003)

4) Imports

All Canadian turkey imports are from the United States. Under NAFTA, a quantity (quota) of turkey products amounting to 3.5% of Canadian domestic production

in the previous year may be imported into Canada at the zero tariff rates. Under the WTO agreements, the Tariff Rate Quota[3] (TRQ) covers access to the Canadian turkey market. The turkey TRQ is allocated between two groups: traditional turkey importers (firms that import turkey prior to the imposition of import controls in 1974), and processors of turkey products that are not on the Import Control List, to the extent that there is a need for such production. Supplementary import permits for turkeys are issued to prevent shortages in the Canadian domestic market.



(Source: USDA, Production, Supply, and Distribution Database, 2003)

1.3 The Relationship between the U.S. and Canadian Poultry Markets

The United States and Canada are two of the world's largest exporters of agricultural goods and they compete with each other in major foreign markets. The U.S. market for agricultural commodities is substantially larger than the corresponding Canadian market. However, the monetary exchange rate, relative prices, trade policies,

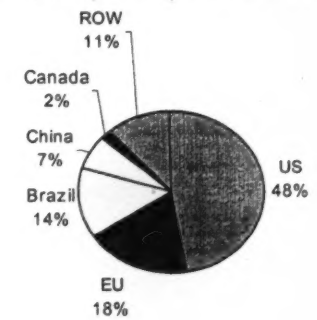
[3] A trade policy instrument used to protect domestically-produced commodities or products from competitive imports, which combines quotas and tariffs.

and other factors can make Canada an attractive export market for the United States. The chicken and turkey trade between Canada and the U.S. is an important issue for the Canadian poultry industry.

1.4 Competitors in International Markets

Canada's main competition in the poultry export market comes from the U.S., the EU, and Brazil. Together, these countries make up 78% of total world poultry exports (Figure 1.9). As is evident in the chart, the U.S. is the largest poultry exporter in the world, followed by the EU, Brazil, and China. Canada accounts for two percent of the world's poultry export market. This group of exporters can be divided into two classes: the low-cost producers (China and Brazil), and the subsidizers (the U.S., EU and Canada).

Figure 1.9 Canada in the International Poultry Market - Export Shares, 1996-2003



(Source: USDA, Production, Supply, and Distribution Database, 2003)

1.5 Research Problem

Canadian poultry producers and processors' welfare have likely benefited from their exports. Producers and processors need market information to determine the optimal quantity and quality of poultry to sell to the export market, both for short-term profitability and long-term growth of the industry. The question facing the Canadian poultry industry is what to produce and where to export it.

Under supply management, Canadian poultry production is controlled by the poultry marketing boards. The domestic poultry price in Canada (171 U.S. cents/kg in 2001) is high compared to the international market (137 U.S. cents/kg in 2001). Currently, Canada is exporting poultry products at the world market price, which is lower than the price in its domestic market. The future growth potential for Canadian poultry exports is dependent on the multiple country policies and the outcome of the next round of trade talks.

One of the obstructions to Canadian poultry exports is the effect of export subsidies by the U.S. and EU. It is of great importance and interest for Canadian poultry processors and producers to know what effects these impediments may have on Canadian poultry exports. Therefore, the purposes of this dissertation are:

a) To examine the implications of different domestic export policies for Canadian poultry producers/processors;
b) To evaluate the effects of the different policies of major export competitors on Canadian and international poultry markets (e.g., export subsidies); and
c) To examine the poultry market structures in Canada and other export competitors.

1.6 Objectives

The objectives of this dissertation are listed below:

Objective 1: Estimate and simulate a model of poultry trade for major poultry trading countries under the assumption of product homogeneity, and incorporating imperfect behaviour;

Objective 2: Evaluate the impacts of the different regional policies on Canadian and other countries' poultry industries by a simulation approach;

Objective 3: Analyze the impacts of trade on the welfare of Canadian consumers, processors, and producers, due to the impact of different trade policies.

1.7 Outline of the Dissertation

Chapter 2 begins with a discussion of the criteria used to select an appropriate analytical technique. The theoretical framework, the data sources and descriptions are presented in Chapter 3. In Chapter 4, the regression results of the base models, as well as the validation of the model are discussed. Different policy simulation analyses and their results are presented in Chapter 5. Finally, the conclusions and limitations of this study, as well as avenues for future research, are discussed in Chapter 6.

CHAPTER 2

LITERATURE REVIEW

The development of an econometric model is an important component of this study. The characteristics of the international poultry market must be described in order to specify the model for this research. This chapter provides details on how to best choose the specification to examine the implications of different international and Canadian policies on poultry markets. It also provides a summary of the key methods used by other researchers and a review of empirical work in agricultural commodity trade modeling.

This chapter is organized as follows: The first part outlines the criteria used to choose an appropriate trade model and estimation approach under certain techniques. Second, information on the policies of the major poultry trade countries will be introduced. These policies will be incorporated into the policy simulation model to examine their potential impacts on the Canadian and international poultry markets. Third, an empirical framework is generated, followed by a discussion of the related previous studies. Such studies include demand, supply and consumer behaviour analyses for the poultry market. Finally, the welfare analysis methodology for the current study will be introduced in the fourth section.

2.1 Trade Model Specification

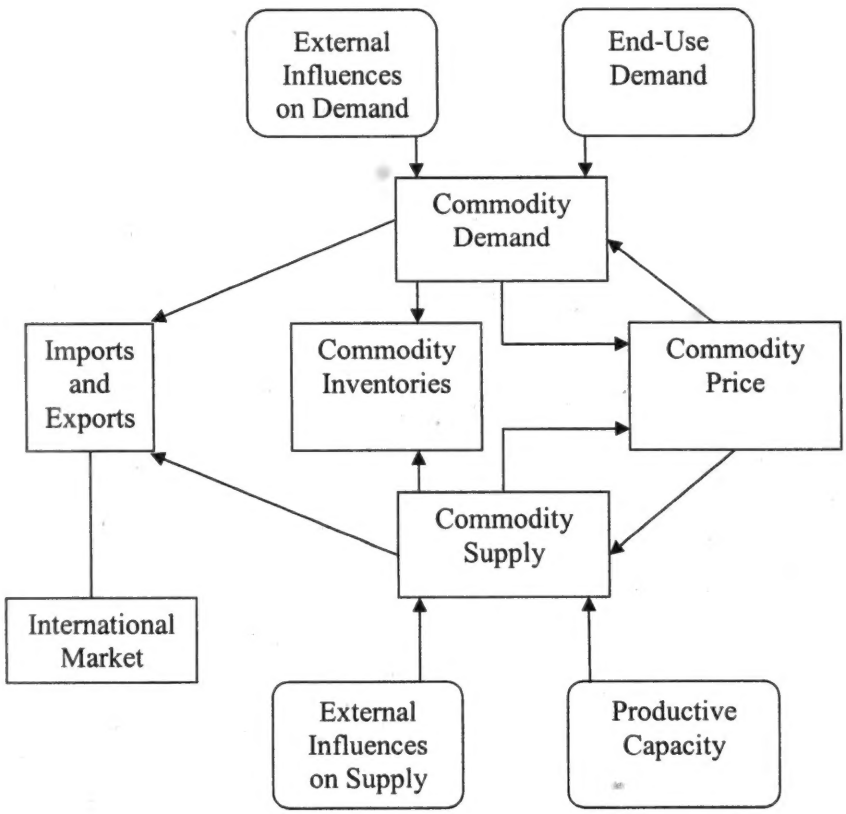
2.1.1 Empirical Techniques

A commodity model is defined as the relationships reflecting the demand and supply aspects of price determination as well as other related economic, political, and

social phenomena. This section presents the basic methods of constructing commodity models.

2.1.1.1 Structure of Commodity Models

Figure 2.1 Trade Model Structure



(Source: Labys and Pollak, 1984)

The basic components for constructing a commodity model include demand, supply, and price determination. *Labys and Pollak (1984)* presented a possible relationship between these components. As illustrated in Figure 2.1, commodity demand and supply depend on prices and external influences (such as government policies, climate, taste, and culture). Productive capacity is another factor affecting the supply side of commodity models.

Commodity demand and supply in turn have an effect on commodity inventories, which are always held by the domestic government or market participants. Government intervention in poultry markets takes various forms, such as supply management in Canada, and poultry export subsidies from the U.S. and EU. Depending on the relative elasticities of demand and supply, and the size of the industry inventory policies play a significant role in price adjustment. The interrelationships among supply and demand can also determine the price level, imports, and exports. Different regional price levels could affect trade flows.

2.1.1.2 Global Trade Models

2.1.1.2.1 Market Equilibrium Model versus Time Series Projection Models

Time series projection models attempt to forecast the future on the basis of the extrapolation of historical data. *Tongeren et al. (2001)* noted that these models typically place more emphasis on the statistical behaviour of time series data than on the economic theoretical underpinnings of behavioural equations. *Kapombe and Colyer (1999)* modeled U.S. poultry exports with this type of model, in order to examine the policy effects on international markets.

Market equilibrium models contain the response (behaviour) of economic agents to changes in prices (costs), and prices adjust so as to clear markets. The objective of these models is to determine equilibrium prices and quantities in (interrelated) sets of markets. Therefore, demand and supply equations are usually included in the market equilibrium model. The market equilibrium model can be classified into partial and economy-wide models.

2.1.1.2.2 Partial versus Economy-Wide Models

Partial models treat international markets as a selected set of trading goods, such as agricultural goods. In other words, they only focus on the trade of particular commodities. Most partial models include linear or log-linear equations as the representation of supply and demand relationships. Exogenous variables such as technical change, world population and household income are also usually incorporated into these equations. In contrast, economy-wide models provide a complete representation of national economies and a specification of trade relations between economies. Economy-wide models capture the implications of international trade for the economy as a whole, covering the circular flow of income and expenditure and taking care of inter-industry relations (*Tongeren et al. 2001).* In the current study, international poultry trade resulting from policy changes is focused on. Only poultry products are chosen for the traded goods to estimate trade flows. It is difficult for the economy-wild models to capture this effect since they treat international trade goods as a whole. Thus, a partial equilibrium model is appropriate to the current study.

2.1.1.3 Parameter Estimation Approach

The chosen partial equilibrium model can be estimated by two different approaches: econometric and synthetic approaches. These two approaches may produce similar results, but in different ways and with different limitations.

1) Econometric Approach

For an econometric approach, a parametric functional form is always chosen to represent the demand and supply functions for producer and retailer levels, price

transitions and government intervention. Under a number of strong economic behavioural assumptions, such as utility maximization, cost minimization or profit maximization, these functions can be estimated *directly* (maximizing a utility function subject to certain budget constraints) or indirectly (minimizing an expenditure function subject to a given utility level). Estimation techniques either minimize the regression sum of squared residuals, or maximize a likelihood function. Estimated parameters are then tested for statistical significance. This method typically incorporates times series data. The data requirements are usually demanding using this approach. The limitation of this approach is the requirement of sufficient degrees of freedom. This requires that each equation possess fewer parameters than the number of observations.

2) Synthetic Approach

The synthetic approach is also called the calibration method. Many researchers have used this approach to generate a set of parameters that are consistent with both the benchmark data and the model's theory. The synthetic modeling approach typically involves the use of parameters (elasticities) that have been reported in previous studies. Thus, calibration exploits theoretical restrictions, equilibrium assumptions and assumptions on functional forms to arrive at a point estimate (*Tongeren et al. 2001)*. Since this type of approach always depends on the work of others, it is based on the quality of the previous modeling efforts. The limitation is that depending on the parameters, the responsiveness of the model to variable shocks is different. *Davis and Espinoza (1998)* pointed out that one of the major shortcomings of the synthetic approach was that the structural elasticities were assumed to be known with certainty, which might bias the results. Compared to the econometric approach, the data requirements of the

synthetic method are not as demanding as econometric methods; observations are required for a given year, and therefore the annual data is satisfied under this concern.

2.1.2 Criteria for Model Selection

The purpose of this section is to select a technique that is sufficiently accurate to investigate the impact of various polices on Canadian and international poultry markets. Some conditions limit the research scope, including time limitations, research difficulties, and budgets. These limitations may force researchers to make decisions that can affect the implementation of the results of the study.

Data is crucial in the choice of a technique. Without data, no researcher can provide reliable estimated results of any policy analysis. Therefore, the technique of choosing an appropriate data set is essential. A major concern in this study is how government intervention affects international and Canadian poultry markets. To solve this problem, one could choose monthly, quarterly, or annual data. For the current study, annual data is used since policy changes are not dramatic over short periods. Annual data can capture the effects of the policy changes on poultry trade in a reasonable manner. Moreover, it is often difficult to obtain quarterly and weekly data for many countries.

Time is also an important factor in the choice of a technique. Researchers always wish to create as realistic a setting as possible. In doing so, many factors and markets may be considered such that there is a reasonable time required for specifying and estimating the model. One part of the technique selection is therefore to trade complexity for reasonable completion times. Based on international historical trade data, poultry trade has become increasingly important since the 1970's. In the current study, the

estimation time period is chosen using data from 1976 to 2001. There are a variety of reasons for choosing this time period in the study. First of all, how the policies affect international poultry trade in recent years is the major concern. Historical data before 1976 may not be useful for this point. Second, to accomplish econometric estimation for the model a shorter period of analysis may bias the results from a statistical point of view.

According to the basic trade specification and background information in the previous section, the type of trade model and estimation approach will be chosen for the current study. In the following section, a discussion of previous trade studies is presented. In order to model Canadian and international poultry trade, certain characteristics are introduced including homogeneous products and the policy issues in the main poultry trading countries.

2.1.3 Homogeneous Products versus Heterogeneous Products

In classical trade models, goods are assumed to be identical for the consumers. Under this assumption, domestic goods are perfectly substitutable with those of other countries. Many researchers (*Alston, 1986*; *Bhati, 1987*; *Kapombe and Colyer, 1999*; *Moschini and Meilke, 1991*; *Narrod, 2001*) assumed poultry was homogeneous products in the world market, and as such, all poultry products were the same and perfectly substitutable.

Heterogeneous products are products that differ in their attributes, that is, goods are imperfect substitutes from the perspective of the buyer. There are two ways to incorporate product differentiation into trade models. First, product differentiation is introduced by assuming that products are differentiated by country of origin (*Tongeren et*

al. 2001). Armington (1969) introduced this method. *Haley (1990) and Alston (1986)* examined the effectiveness of the export subsidies from U.S. and EU on poultry trade with this type of model. Second, poultry can be differentiated by product attributes, like white meat and dark meat. In the current study, poultry products are assumed to be homogeneous due to the tremendous additional complexity associated with heterogeneity.

2.1.4 Previous Studies of Trade

In this section, some previous studies are presented. These studies include both Canadian and non-Canadian poultry or meat trade models. Based on this review, the characteristics of the model are discussed and similarities and differences between previous works are presented. Past research efforts are summarized in Table 2.1 (Page 24). It provides author, countries examined, functional form, main objectives and general results.

Previous studies have modeled agricultural international trade in many different ways and under different assumptions. *Haley (1990)* modeled the effects of the Export Enhance Program (EEP) on poultry exports from the United States. In his study, poultry products are differentiated by country of origin. An econometric analysis was not adopted in Haley's paper because the EEP had not been in existence long enough to provide sufficient observations for parameter estimation. Therefore, a synthetic approach was adopted, in which poultry products were differentiated by country of origin. There are 6 exporters (Brazil, EU, Hungary, Thailand, U.S., and Rest of World) and 11 importers (Sub-Saharan Africa, Caribbean Islands, European Union, Egypt, Gulf States, Hong Kong, Iraq, Japan, Saudi Arabia, Soviet Union, and the rest of world). Each

importer had a separate demand schedule for poultry from each of the exporting regions, and each importer's demand for domestically produced poultry was not distinguished from imports from the rest of the world. The findings indicate that the EEP helps the U.S. increase its poultry exports.

Alston and Scobie (1987) examined the effects of EU common agricultural policy (CAP) on the EU's poultry trade with a partial equilibrium model. The synthetic approach was adopted in their study. There were two sections in the paper. First, poultry meat was treated as homogeneous products. Second, poultry meat was differentiated by different countries of origin. Poultry products from the EU were assumed to be different from the U.S. and other countries. The world was decomposed into six regions, including three major exporters: the EU, the U.S. and Brazil; and three major importers: Japan, the Middle East and the rest of the world. The results under the two assumptions were similar. Both indicated that the EU export subsidies helped the EU increase its poultry exports and at the same time the exports of the U.S. were decreased.

In addition, *Alston (1986)* examined the effects of the CAP on poultry international trade. In his study, homogeneous products and perfect competition were assumed. A comparative static partial equilibrium model was applied using an estimation method similar to his 1987 study. The author used demand and supply elasticities from previous studies while a simulation approach was adopted. The results indicate that the CAP made the EU a net exporter rather than a net importer of poultry.

Ker (1997) discussed the Canadian chicken industry under the Uruguay Round Agreement. In this study, he attempted to find a tariff scheme that replaces the NTBs (non-tariff barriers) under the assumption of imperfect competition. A nonparametric

kernel density technique was applied in which the author considered the conversion of non-tariff barriers into bound tariff schemes by matching either the first moments of the marginal domestic price densities under both states, or the first moments of the marginal import quantity densities under both states. The results suggest that a high tariff (100%-125%) might keep the import level of Canadian chicken constant.

Patterson et al. (1996) analyzed whether subsidies promoted new firm market entry and whether firm characteristics were influenced by EEP participation. Trade in three commodities (poultry, wheat, and wheat flour) was analyzed using firm-level data. A logit model was used and the econometric approach was adopted. It was found that market entry by new firms was not significantly higher among subsidy recipients and past program participation strongly influences the current program participation.

Most trade studies (*Alston and Scobie, 1987*; *Alston, 1986*; *Paarlberg, et al. 2001*; *Conforti, 2001*; *Haley, 1990*; *Fulton and Tang, 1999*; *Kapombe and Colyer, 1999*; *Narrod, 2001*; *Bhati, 1987*; *Moschini and Meilke, 1991*; *Wohlgenant, 1989)* in Table 2.1 adopted partial equilibrium trade models. Some of the studies (*Haley, 1990*; *Alston and Scobie, 1987*; *Alston, 1986*) used the synthetic approach. In other words, the demand and supply elasticities in these studies were obtained from previous studies rather than estimated by the authors themselves, as the data period was not long enough to provide sufficient observations for parameter estimation (*Haley, 1990*).

2.1.5 Summary

In this section, the structure of commodity models was first introduced, followed by a comparison of different trade models and estimating approaches. Then, summaries

of the previous trade studies were presented. Among these previous studies, it was found that the reviewed researchers chose either the econometric or synthetic approach, and partial equilibrium models were used. These findings support the choice of one trade model, especially the partial equilibrium model with the assumption of homogeneous products.

Moschini &.Meilke 1991	_examined the conversion of import quotas into tariffs for the U.S.-Canada chicken trade	_homogeneous products _market power	1980-1989	Chicken	U.S. Canada	_tariff and quotas were equivalent under perfect competitive conditions _under the supply management tariff and quotas were not the same	Partial Equilibrium Model with Linear Functional Form
Narrod 2001	_measured the importance of different types of technology and of public investments on poultry industry	_perfect competitive markets _homogeneous products	1961-1996	Poultry	25 Countries	_model imported inputs such as foreign breeds of broilers and compound feed was very important	Linear Production Function
Paarlberg et. al. 2001	_evaluated how export subsidies affect the intermediate goods trade	_two countries _perfect competition	1980 - 1989	Bulk Commodity	U.S. ROW	_export subsidies on the higher-value agricultural commodities may lower the bulk commodities' price	Partial Equilibrium Model with Linear Functional Form
Wohlgenant 1989	_Provided retail to farm demand linkages for consumer demand and producer supply relationship	_perfect competitive market _the proportions between the farm product and marketing inputs were not fixed	1956-1983	beef pork poultry dairy Fruits	U.S.	_derived demand elasticities that were at least 40% larger compared to those derived assuming fixed proportions	Partial Equilibrium Model with Linear Functional Form

Conforti 2001	_looking for the characteristics of a partial equilibrium model for simulating the effects of the CAP	N/A	N/A	N/A	EU and ROW	_the five CAP tools benefited the EU producers, and improved the level of exports (CAP tools: direct price support, trade measures, supply management tools, partial "decoupled" payments, and voluntary schemes.)	Partial Equilibrium Model with Linear Functional Form
Fulton & Tang 1999	_checked if there was market power in both processor and retail sector in the Canadian chicken industry	_imperfectly competitive market	1965 - 1985	Poultry	Canada	_market power in either the processing or retailing level result in higher retail prices.	Partial Equilibrium Model with Translog Functional Form
Haley 1990	_analyzed the effects of the EEP on poultry exports	_poultry products were differentiated by country of origin	1987	Poultry	U.S. EU and Other Countries	_U.S. poultry exports increased due to EEP _Increased U.S. poultry exports had resulted from expansion in the world poultry markets rather than from a displacement of competitors	Armington Model
Kapombe & Colyer 1999	_to provide information that could be used to help encourage exports of chicken products from the U.S.	_perfectly competitive _homogeneous products	1970-1993	Chicken	U.S. Japan Canada Mexico	_export markets were more price responsive than the domestic markets _government intervention in the Canadian and Mexican markets reduced their imports, and the exchange rate had significant impact on the level of exports	Partial Equilibrium Model with Linear Functional Form
Ker 1997	_found a tariff scheme that replaced the NBTS _examined the effects of replacing the NBTs with a tariff	_imperfective market structure	1986-1988	Chicken	Canada U.S.	_the NTBs increased the imports from U.S. to Canada	Non-parametric Kernel Density Techniques

Moschini &.Meilke 1991	_examined the conversion of import quotas into tariffs for the U.S.-Canada chicken trade	_homogeneous products _market power	1980-1989	Chicken	U.S. Canada	_tariff and quotas were equivalent under perfect competitive conditions _under the supply management tariff and quotas were not the same	Partial Equilibrium Model with Linear Functional Form
Narrod 2001	_measured the importance of different types of technology and of public investments on poultry industry	_perfect competitive markets _homogeneous products	1961-1996	Poultry	25 Countries	_model imported inputs such as foreign breeds of broilers and compound feed was very important	Linear Production Function
Paarlberg et. al. 2001	_evaluated how export subsidies affect the intermediate goods trade	_two countries _perfect competition	1980 - 1989	Bulk Commodity	U.S. ROW	_export subsidies on the higher-value agricultural commodities may lower the bulk commodities' price	Partial Equilibrium Model with Linear Functional Form
Wohlgenant 1989	_Provided retail to farm demand linkages for consumer demand and producer supply relationship	_perfect competitive market _the proportions between the farm product and marketing inputs were not fixed	1956-1983	beef pork poultry dairy Fruits	U.S.	_derived demand elasticities that were at least 40% larger compared to those derived assuming fixed proportions	Partial Equilibrium Model with Linear Functional Form

2.2 Government Intervention in World Poultry Market

Government policy typically affects world trade behaviour. The purpose of the policies of most countries is to maintain an "acceptable" income level in the agricultural sector. This level differs from country to country and often depends upon the size of the agricultural industry and the amount of political power the particular government wields. There are various forms of government intervention. For example, Canada has had import quotas, which have been replaced by import tariff rate quotas after the Uruguay Round Agreement in 1995. The Canadian poultry industry is also working under supply management. The European Union has a Common Agriculture Policy, while the U.S. has an Export Enhancement Program. Even though these policies differ from country to country, trade policies can be grouped into export subsidies, tariffs, import quotas, domestic production quotas and tariff rate quotas. The basic theories of these policies are presented in Appendix C. In this section, the different policies in the major poultry trade countries will be discussed. This information will help to conduct trade policy simulations in a later chapter.

2.2.1 Canada

2.2.1.1 Canadian Supply Management (SM)

Supply management is defined as centralized control over the quantity and/or price of commodities of specified quality, being produced by or coming from a known group of producers to a particular market in a given period (*Hiscocks and Bennett, 1974*). In other words, supply management refers to the regulatory power given to

national marketing agencies to manage supply in order to improve the stability of prices and income for producers.

In Canada, there is an independently operated national supply management system at the farm production level for chicken and turkey, which is monitored by the National Farm Products Council. The producers control the production and the government controls imports. The regulatory agencies then have some ability to determine producer prices. The national producer agency, in consultation with the processors at the national level, set the total Canadian production requirements. These requirements are subsequently divided among provincial producer marketing boards, taking into account the criteria contained in the federal/provincial agreement. For chicken, the national production requirement is determined through a "bottom-up" approach whereby provincial-level market requirements are determined by each provincial commodity board through consultation with their processors *(Agriculture and Agri-food Canada, 2001)*. For turkey, the national producer agency, in consultation with the processors at the national level, sets the total country's production requirements. The national production allocation then becomes the sum of the provincial requests. At the provincial level, provincial boards allocate quotas to producers and negotiate quantities with processors with reference to cost of production estimates.

Supply management has many impacts on the Canadian poultry industry. As a general rule in agricultural markets, supply tends to be relatively more responsive to prices (at least to price increases) than does demand (*Coffin, et al. 1989*). Supply management, as an effective form of government intervention aims at helping these poultry producers transfer risk and capture benefits in their own interests to the detriment

of others (particularly, consumers) in the system. Supply management potentially provides producers with countervailing power against consumers.

In addition, the GATT agreement on agriculture requires that import quotas should be replaced by tariff equivalents. *Coffin, et al. (1989)* pointed out that under supply management, real prices for poultry at the farm gate had declined 33 to 40 cents per kilogram across the various regions during 1976 to 1986. Processor prices tend to come down a bit more. Canadian chicken processor price in 2003 was CAN 2.65$/kg, and farm price at the same time was CAN1.12$/kg. Processor prices tend to come down a bit more. Canadian turkey processor price in 2003 was CAN 1.52$/kg, and farm price at the same time was CAN1.32$/kg.

It has been argued that supply management contributes to an inefficient use of resources, low productivity and reduced competition in the marketplace. Some researchers (*Schmitz and Schmitz, 1994; Coffin, et al. 1989; Veeman, 1988)* pointed out that the costs of supply management were imposed on the consumers. They also claimed that any existing short-term benefits for producers became capitalized into quota values and removed from the industry with the first transfer of ownership.

2.2.1.2 Canadian Poultry Export Policies

In 2001, the Chicken Farmers of Canada (CFC) developed a Market Development Policy. The objective of this policy is to help Canadian chicken producers to develop and export producers. Also, the CFC would like to facilitate the planned use of chicken, which should be consistent with Canada's international trade rights and obligations.

This policy regulates the responsibilities of provincial commodity boards, the CFC, and market development license holders. It regulates the allocation of market development production quotas, the producer restriction, and import and export behaviours, and the evaluation process.

In one section, the allocation of the market development quota is regulated:

> "In reporting its periodic market requirements to the CFC, each provincial board will indicate the quantity of kilograms of market development quota required for the quota allocation period. The CFC's periodic allocation to each provincial board will be comprised of separate components including one for market development quota and one for domestic quota. The 2% overproduction sleeve will apply to a province's domestic allocation plus its market development commitments for the period. Only federally inspected primary processors can request Market Development production from provincial boards. Brokers, wholesalers, further processors and other parties are to make appropriate arrangements with primary processors for their market development requirements." *(Chicken Farmers of Canada, 2001, page 5)*

These regulations show that the CFC is encouraging the chicken producers to develop the exports by applying for the market development quota. However, in the "Limitation" section, the policy states that "the market development quota allocation to each province will be capped at 14% of the domestic quota allocation period. The cap may be changed by the CFC Board of Directors by a double majority vote" *(Chicken Farmers of Canada, 2001)*. Contrary to the turkey export policy, the "Market Development Policy" does not count the export quota as domestic production credits. Therefore, domestic chicken supply is isolated from the exports.

In 2000, the Canadian Turkey Marketing Agency (CTMA) summarized the export policy for facilitating Canadian turkey producers and processors to engage in export opportunities. There are four main components in this policy: 1) Production for export

markets; 2) live turkey exports; 3) export policy compliance; and 4) supplementary import permits for export purposes.

In the first section, it states that:

> "to maintain domestic supply requirements, any province which has exported young turkey grown within quota, will be eligible to apply for export credits; where production of young turkey is required over and above a province's allocation for the purpose of an export market, a conditional permit may be issued by the CTMA to the provincial Commodity Board; In order to maintain domestic supply requirements, only registered turkey producers may participate in the production for export market; For those eviscerated and boneless exports derived from authorized production under conditional permits, the following minimum percentages of live weight produced must be exported:
>
> (i) For Whole Eviscerated Exports:
> Broiler Turkeys..... 81%
> Hen Turkeys..... 82%
> Tom Turkeys..... 83%
>
> (ii) For Bone-in and/or Boneless Exports: a minimum of 59% of the total live weight produce must be exported." *(Canadian Turkey Marketing Agency, 2000, pages 1-5)*

In the second section, the policy regulates live turkey exports. Any export of live young turkey must receive authorization by the respective provincial commodity board and the Agency, thirty days prior to poultry placement. Should birds placed for live export not be exported, but marketed domestically, they will be considered as domestic marketing under provincial marketing allotments.

The third section ("export policy compliance") describes how the policy regulates the export credits of Canadian turkey:

> "Export credits shall be issued only for those exports sold by a CTMA licensed Canadian producer or processor. Credits will not apply to re-imported products and the exported products exporting back into Canada. Export product inventories will be reported through the Provincial Commodity Boards. The determination of the application for export credit

> carry forward is made between the provincial board and exporters in each province. Provincial boards ensure the timing of re-grow under the carry forward occur in consultation with exporters and processors."*(Canadian Turkey Marketing Agency, 2000, page 8)*

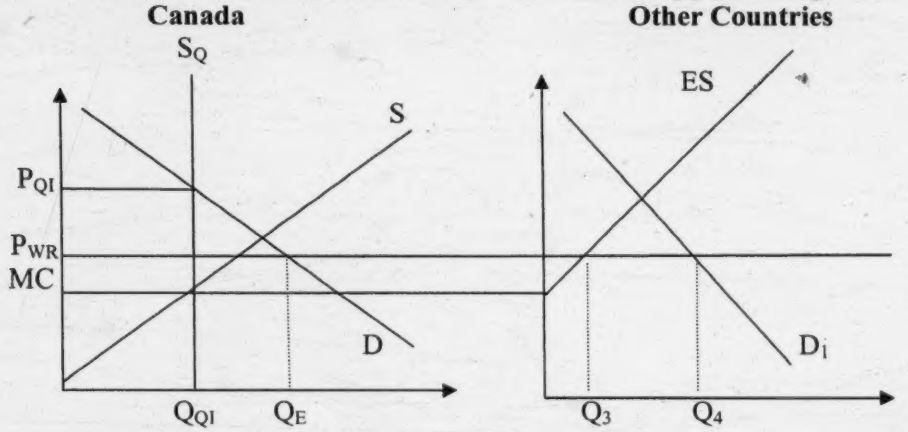
The fourth section, "Supplementary Import Permits for Export Purposes" regulates that CTMA export credits do not apply to exported product for which raw material has been imported. Only the turkey produced by the local farmers is eligible to apply for the export credits.

Again, the policy regulates that the province that has exported young turkey grown within quota will be eligible to apply for export credits. Therefore, Canadian turkey producers' production for the purpose of export could be one part of their domestic production quotas. Their production quotas for the domestic supply are combined with their exports. This can make farmers consider the exports and the domestic supplies as a whole. Contrary to chicken producers, turkey export policy does not have separate quota for producing turkey for export purpose only. This indicates that turkey production after the exports may not increase as much as for the chicken market and turkey production would have been lower without the exports.

Based on the export policies for chicken and turkey, it is found that the marketing board has regulated the proportion of poultry exports for producers. Based on the data, the export value of chicken and turkey had been increasing from 1993-2001, and the average export quantity during this time was 44,666 tons per year. In 2001 the Canadian average export prices for chicken and turkey were USD1.02/kg and USD1.28/kg, respectively. During the same time, the Canadian domestic prices for chicken and turkey were USD1.68/kg and USD1.75/kg. The reason for the significant difference is that the

Canadian market is operated under supply management. Therefore, the domestic price in Canada is much higher than its export price (Figure 2.2).

Figure 2.2 Canadian Poultry Domestic Market under Supply Management



where:

D = demand curve for poultry;
S_Q = supply curve of poultry with quotas;
D_I = demand in international market;
P_{QI}, Q_{QI} = market equilibrium point;
Q_E-Q_{QI} = the export volume;
S = supply curve for poultry;
ES = excess supply curve of Canada;
P_{WR} = Canadian export price level;
MC = marginal cost of production;
Q_4-Q_3 = total international imports.

2.2.1.3 Import Tariff Rate Quotas

Prior to 1995, the Canadian government imposed import quotas in order to protect its domestic production. Under these quotas, only a certain quantity of poultry could be imported into the Canadian market. According to GATT and WTO, Canada changed its agricultural imports to a tariff rate quota (TRQs) system in 1995. Under the TRQs, imports within the quota are subject to low rates of duty; otherwise the higher rate duty needs to be charged.

Chicken and turkey products were originally placed on the Import Control List (ICL) in October 1979 and May 1974, respectively and then removed and replaced under

the Canada-U.S. Free Trade Agreement (FTA). The import quota levels for chicken and turkey are established at 7.5% of the previous year's domestic production of chicken and 3.5% of the current year's domestic production of turkey, respectively *(Agriculture and Agri-food Canada, 2001)*.

In 1995, Canada was required to provide access at lower tariff rates for imports within tariff-rate quotas. Imports in excess of a specified quota were subject to higher tariffs based on tariff equivalents calculated from the 1986 to 1988 URAA base period. The within quota tariff rates were completely eliminated on January 1, 1998 as governed by NAFTA, and the tariff applicable to over-access rate imports declined by 15% between 1995 and 2000 *(Agriculture and Agri-food Canada, 2001)*.

In 2000, the within-quota tariff for live chicken was free on imports from the U.S. and 1.90 cents/kg on imports from most other countries. The over quota tariff was 238% but not less than $1.25/ kg. For chicken products, the within-quota tariff was free on imports from the U.S. and varies from free to 7.5% on imports from most other countries. The over-quota tariff varies from 238% to 253% in 2000 *(USDA, Agricultural Trade Policy Comments Database, 2001)*. In the same year, the within-quota tariff for live turkey was free on imports from the U.S. and 1.9 cents/kg on imports from most the other countries. The over-quota tariff was 154.5%, but not less than $1.60/kg. For turkey products, the within-quota tariff was free on imports from the U.S. The over-quota tariff varies from 154.5% to 169.5% *(USDA, Agricultural Trade Policy Comments Database, 2001)*.

2.2.2 The United States

The United States is the world's largest net exporter of poultry products. Currently, the U.S. is maintaining its export situation in the world poultry market. Broiler exports for 2002 were forecast to reach a record of 2.9 million tons, up nearly 3 percent. In 1996, the U.S. government published the "U.S. Farm Bill", after which the government reduced the level of subsidies offered to the U.S. agriculture sector. This section introduces the U.S. policies, which could affect its poultry exports.

2.2.2.1 The U.S. Agricultural Export Enhancement Program (EEP)

The U.S. has a sophisticated agricultural export promotion system, which applies worldwide. Under this system, some programs are created for promoting U.S. agricultural exports, the U.S. Export Enhancement Program (EEP) being one of them. The EEP was announced by the USDA on May 15, 1985, and among other commodities subsidizes exports of poultry to selected foreign markets. The primary motive of this program is to meet competition from subsidizing countries, especially those in the European Union. Under the program, the USDA pays cash to exporters as bonuses, allowing them to sell U.S. agricultural products in targeted countries at prices below the exporter's costs of acquiring them. The purpose of this program is to support U.S. agricultural food market price. Since its inception, the EEP has played a significant role in the export of many agricultural commodities.

Consistent with its export subsidy commitments under the Uruguay Round Agreement on Agriculture, the United States has established annual ceilings by commodity with respect to export quantities and budget outlays. The commitment to

respect the quantity and budgetary ceilings became effective on July 1 and October 1, 1995 respectively. After that, the United States established both quantity and budgetary outlay ceilings for subsidized exports of poultry. The final year commitments are required 21% and 36% below the 1986-1990 bases for the quantitative and budgetary commitments, respectively *(USDA, Foreign Agricultural Service: GATT/WTO and Poultry and Eggs, 2001)*. The U.S. poultry export subsidy values are introduced in Chapter 5, and they will be included in the model to conduct the policy simulation.

2.2.2.2 Farm Loan Programs

The Farm Service Agency (FSA) administers the Farm Loan Program. It is one of the most efficient ways to expand chicken industry in the U.S., and is offered to farmers who are unable to get loans elsewhere. New farmers who lack the track record and equity to get commercial credits are assisted under this program *(USDA, Farm Service Agency: Farm Loan Programs, 2001)*. No statistics are available from the USDA with respect to the usage of the program by the poultry industry. However, the program helps the U.S. poultry industry to be integrated to some extent.

2.2.2.3 Market Access Program

The Market Access Program (MAP) assists U.S. producers, exporters and private companies in enhancing their sales. The Export Incentive Program (EIP), under the MAP, helps the U.S. to promote their business in many ways: advertising, in-store demonstrations, and trade seminars. The EIP provides up to 50 percent of the costs of branded product activities on a cost-shared basis with individual companies. In 2002,

MAP spent a total of $90,000,000 on agricultural creation, expansion, and maintenance of foreign markets for U.S. agricultural products, and $2,387,104 (about 2.65 percent) was allocated on the U.S. Poultry and Egg Export Council *(USDA, Farm and Commodity Policy: Program Provisions, 2001).*

2.2.2.4 The National School Lunch Program

The National School Lunch Program is a federally assisted meal program that operates in about 94,000 public and non-profit private schools and residential childcare institutions. Under this program, more than 26 million children in these schools receive subsidies from the USDA for each meal that they serve. However, the amount of poultry used in the program is small compared to total poultry production in the U.S. Therefore, the impact of this program is insignificant with respect to domestic chicken prices.

2.2.3 European Union

Poultry market protection by the EU government consists of various indirect intervention and market support arrangements. The main goal of these policies is to protect producers from low-priced imports from the competing countries. The first of three of these methods is to impose the sluicegate price level for the import products. A sluicegate price is a theoretical minimum price calculated by the government at which third country poultry meat should reach the EU. Second, the government could impose basic import levies for all the poultry products. Third, an export refund enables EU exporters to compete with other countries by lower feed prices on the world market.

Refunds may also be used to increase exports when the EU is oversupplied *(Bishop et al. 1990)*.

The Common Agricultural Policy (CAP) is one of the most important polices of the EU. The objectives of the CAP are to increase agricultural productivity, ensure a fair standard of living for farmers, stabilize markets, guarantee regular food supplies, and ensure reasonable prices to consumers *(USDA, European Union: Policy, 2004)*. In the 1970's, the CAP started supporting producer prices at levels that are generally above world prices. In order to export commodities to other markets, the EU subsidized the exports to compensate for the difference between the EU and world market prices. Prior to the Uruguay Round Agreement on Agriculture in 1995, the U.S. and EU were the two largest users of agricultural export subsidies. Export subsidies have been regulated due to Uruguay Round Agreement on Agriculture agreements since July 1, 1995. After that, the EU continued to subsidize its poultry exports under certain subsidized ceilings. In 2000, the EU's maximum allowable quantity of subsidized poultry exports was 291,000 tons, 179,000 tons below the quantity of subsidized exports in 1991-1992 *(USDA, Foreign Agricultural Service: GATT/WTO and Poultry and Eggs, 2001)*. The EU poultry export subsidy values are introduced in Chapter 5, and they will be included in the model to conduct the policy simulation.

2.2.4 Brazil

In the mid-1970's, the Brazilian government committed large funds to new poultry facilities, in order to encourage growth in the poultry industry. The primary goal of the program was to increase growth in the export market. However, it will take time for producers to get used to operating in the new, large-scale production facilities and

therefore to penetrate the Brazilian domestic market. The Brazilian government does not offer explicit export subsidies in response to their competitors. However, they provide export credits and cash advances to the exporters like an implicit export subsidy.

2.2.5 China

China is the world's second largest producer of poultry meat. This high poultry production is due to the development of domestic demand. China is also a net importer of poultry products. The amount of China's poultry exports has remained constant during the last six years. The main export customers are Russia and Japan. For China's import market, the U.S. is the largest supplier, which accounts for more than 80 percent of the import market in China due to the competitive prices *(USDA, Foreign Agricultural Service Gain Report, 2001)*. The Chinese government issued several regulations on chicken imports in 2000. In past years, it has strengthened policies surrounding anti-smuggling campaigns. After WTO accession, China's tariffs on agricultural products fell from an average of 45 percent to 20 percent. In addition, agricultural imports, like domestic products, are subject to China's value-added tax, which ranges between 13 and 17 percent depending on the product *(USDA, China: Policy, 2003)*.

2.2.6 Japan

The Central Association of the Livestock Industry (CALI) was established in Japan in 1955 and it has contributed greatly to the expansion of the Japanese poultry industry. There are various programs under the CALI, including training farmers for

analysis and research on livestock operations; providing detailed analyses and research on livestock operations; and providing extension and information services.

Input assistance and tariff protections are the other types of policies carried out by the Japanese government. Japan imposes no import quotas on poultry meat. However, tariffs are applied to poultry imports. Due to the GATT, tariffs have been reduced over the last ten years by the Japanese government. Other types of input assistance such as expenditures on credit, research and extension, disaster relief, and farmers' pensions are allocated to poultry producers in Japan (*Bishop et al., 1990*). These policies protect the Japanese poultry industry from the affects of the other competitive countries.

2.2.7 Summary

The trade status and policy issues of the major poultry trade countries have been introduced in this section. These attributes are useful to specify the trade policy simulation model. In the current study, the impacts of Canadian poultry export policies and the U.S. and EU poultry export subsidies on the world trade market will be analyzed in Chapter 5.

In Canada, the poultry industry is under the control of supply management. Poultry export policies are published to encourage exports. The EU and U.S. offer export subsidies to their producers to expand their market shares in the international market. Table 2.2 also summarizes some different trade regimes to eliminate the import barriers in the six most prominent countries. The main poultry importers like Russia, Japan, and China reduced their import tariff rates by different ranges.

As discussed in section 2.1.2, most of the previous trade studies adopted a partial equilibrium model. To analyze these trade models, the estimation of each country's supply and demand are critical. In the following section, consumer and firm theories will be introduced, and a supply and demand model will be specified for this study based on the review of the previous studies.

Table 2.2 Trade Regimes of Poultry Trade Countries

Countries	*Trade Regimes*
Brazil	35% tariffs on all poultry products.
China	Tariff of 45% was reduced to 20% under U.S.-China Agreement if China joins WTO. Further reductions to 10%.
EU	Tariff of 299 ECU/ton on whole chicken and 358 ECU/ton on parts; Export subsidies constrained under WTO.
Japan	Tariffs of 11.9% on whole chicken and 8.5% on parts.
Russia	Tariffs of 30% on chicken and 15% on turkey. Tariffs could be reduced on eventual WTO membership to 10% over 10 years.
U.S.	Tariffs of 8.8 cents/kg for whole chicken and 17.6 cents/kg for parts have been bound in the WTO. Export subsidies constrained under WTO.
Canada	Within quota tariff rate is 1.9 cents/kg (0% for NAFTA countries, The over quota tariff varies from 154% to 169%.

(Source: USDA, GATT/WTO and Poultry and Eggs, 2001)

2.3 Demand and Supply Sector

2.3.1 Demand Model Selection

Demand model selection is central to empirical demand analysis. The objective of this section is to choose a good model to analyze the demand side of the selected countries' poultry industries. The empirical demand framework, followed by a discussion of the related studies of the past will be introduced first.

2.3.1.1 Demand Theory

Consumer behaviour is introduced by demand theory through the specification of a utility function. The objective of this section is to use the utility function to derive the

demand functions. Furthermore, the assumptions made for the demand functions are also exhibited.

Consumer behaviour can be expressed by the following equations:

$$Maximize U = U(q) \quad \text{S.T. } M = \sum p_i q_i \tag{2.1}$$

where U is consumer utility, q_i is consumption of the i^{th} good, M is consumer's income, and p_i is price of the i^{th} good.

The utility function can be used to measure the difference in preferences between different bundles of goods and services. Maximization of the utility function subject to the budget constraint M is carried out by the Lagrangian method:

$$\underset{q_i \lambda}{Max}\, \ell = U(q) + \lambda(M - \sum_{i}^{n} p_i q_i) \tag{2.2}$$

where λ is the Lagrangian multiplier, which is interpreted as the marginal utility of income. Differentiating equation 2.2 with respect to each of the arguments, q_i and λ, yields the following first-order conditions:

$$\frac{\partial \ell}{\partial q_i} = \frac{\partial U(q)}{\partial q_i} - \lambda \cdot p_i = 0 \qquad \forall_i$$

$$\frac{\partial \ell}{\partial \lambda} = M - \sum_{i=1}^{n} p_i q_i = 0 \tag{2.3}$$

Solving these two equations simultaneously provides us with the following:

$$q_i = q_i(p_1, \ldots, p_n, M) \tag{2.4}$$

$$\lambda = \lambda(p_1, \ldots, p_n, M) \tag{2.5}$$

Equation 2.4 is the Marshallian demand function, which is derived from the utility function by way of a constrained optimization. The properties of the demand functions are the adding-up conditions, homogeneity, symmetry, and negativity.

The adding-up conditions require that the total value ($\sum p_i q_i$) of the demand functions equal the total expenditure, while homogeneity requires demand to be homogeneous of degree zero in prices and income. This property can be explained by $q_i(\theta \cdot x, \theta \cdot p) = q_i(x, p)$. The third property is that the cross-price derivatives of the demand functions are symmetric, which means $\partial q_i / \partial p_j = \partial q_j / \partial p_i$. Finally, the property of negativity means the demand functions necessarily slope downward, as the own-price substitution effect is always negative except for Giffen goods. This requires $\partial q_i / \partial p_i < 0$.

2.3.1.2 Single Equations versus Demand Systems

In this section, the single-equation and demand system approaches are compared. The former approach is used when one equation can describe the demand for one good, so the per-capita consumption of a good is estimated by its price, consumer income, and the prices of all other substitutes and complements. The advantage of the single-equation approach is that is easy to be estimated. However, it also has some difficulties in the imposition of consumer theory, since only homogeneity can be imposed in a single demand equation. When the cross-commodity effects are considered, only the demand system allows for the estimation of consumer preferences.

A demand system, on the other hand contains a set of demand equations, which represent several commodities. It allows the relationship between goods to be examined. For demand system estimation, a total expenditure is set and the allocation of total expenditure across a group of goods can be estimated. Restrictions based on consumer theory, such as homogeneity, the adding-up conditions, and symmetry can be imposed in

the system. A demand system always takes multiple stages, such as the *Armington (1969)* framework.

In the current study, poultry retail demand is estimated as one part of the simultaneous equations system. Chicken and turkey are estimated separately as homogeneous products across countries. Intuitively, all chicken (turkey) products are the same. Therefore, a single-equation approach is chosen for the current study.

2.3.1.4 Previous Meat Demand Studies

Although the single-equation approach is adopted, the appropriate variables that should be included in the demand function need to be specified. In this section, some previous meat studies are introduced which might provide some basic ideas of how to model the demand side of the poultry market.

Previous demand studies are summarized in Table 2.3. It includes the author, country examined, commodities, functional forms and conclusions. Some of the studies focus on trade issues. These trade models' demand functions are discussed in this section.

Kapombe and Colyer (1999) analyzed the U.S. broiler trade with a structural time series model. In their study, the retail demand (QBD_t) of the broiler was specified as a linear function of the retail prices of beef (RBP_t), pork (RPP_t) and turkey (RPT_{t-1}), the wholesale price of broilers (WPB_t), per capita income (PCI_t), and its one-quarter lagged (QBD_{t-1}) variable:

$$QBD_t = \mu_t + \gamma_t + \alpha_5 WPB_t + \alpha_6 RBP_t + \alpha_7 RPP_t + \alpha_8 RPT_t + \alpha_9 PCI_t + \alpha_{10} QBD_{t-1} + \varepsilon_{2t}$$

Bhati (1987) modeled the Australian demand for poultry meat per person at the establishment (wholesale) level. In his study, per capita demand was a function of the

poultry meat price, the price of substitute meats, total consumption expenditure per person and seasonal factors. Quarterly data was used for 1971 to1986:

$$DP_{chicken} = f(DP_{t-1}, PM_t, PS_t, CE_t, D_i)$$

where DP = per capita poultry demand, PS = real price of substitute meats like pork and beef, PM = real expected price of poultry meat, and CE = the real total consumption expenditure per person.

Cheney (2001) examined demand specifications with annual U.S. data for poultry. A log demand function was adopted in his study.

$$Q_P = \beta_1 P_P + \alpha_1 P_{PORK} + \alpha_2 P_{BEEF} + DI_i + v_t$$

where Q_P = the log annual per capita poultry (turkey) consumption, P_P = the log real retail poultry (turkey) price, P_{PORK} and P_{BEEF} = the exogenous variables representing the real price of pork and beef, and DI = the per capita disposable real income.

Alston (1986) analyzed the effects of the EU policy (CAP) on international poultry markets. This study used the single-equation with log-log functional form as expressed by equation 2.6. It was a function of the EU consumption of poultry determined by the EU wholesale price of poultry.

$$d \ln D_e = \eta_e d \ln P_e \qquad (2.6)$$

2.3.1.5 Summary

The Marshallian demand functions adopted in the previous studies have prices and income as explanatory variables. At the conceptual level, the retail price of chicken (turkey) and other substitute goods, like beef and pork, in the economy need to be included in the demand equation. From consumer theory, income variables need to be

included in the retail demand model as well. Time trend variables need to be incorporated to capture the consumer taste reference changes. In addition, the consumer price index needs to be imposed as a deflator for holding the homogeneity property. Therefore, the retail demand equation in the current study is:

Retail Demand of Chicken or Turkey = f ($RP_{chicken}$, RP_{turkey} RP_{beef}, RP_{PORK}, INCOME, TIME).

Table 2.3 Previous Studies of Demand Analysis

Author	Objectives	Assumptions	Data	Commodity	Country	Conclusions	Model
Alston & Scobie 1987	_how the EC policy (CAP) effects the international poultry market, particularly for the United States	_ homogeneous products _poultry meat was differentiated by region of origin	1981	Poultry	EU U.S.	_Both results showed the EC policy (CAP) helped increase its poultry exports	Single Equation with Translog Functional Form
Alston 1986	_examined the effects of CAP by EC on the international poultry trade	_homogeneous products _perfect competition	1981	Poultry	EU U.S	_CAP makes the EC became a net exporter rather than a major importer of poultry	Single Equation with Translog Functional Form
Bhati 1987	_quantified the effects on the poultry meat sector of a recent change in the domestic feed wheat marketing policy	_homogeneous products _perfect competition	1971-1986	Poultry	Australia	_the feed wheat marketing policy change increased the level of output and consumption of poultry meat	Single Equation with Linear Functional Form
Cheney 2001	_Wu-Hausman endogenous tests were used to examine demand specifications and industry structure	_perfect competition _homogeneous products	1970-1996	Turkey	U.S.	_price was found to be pre-determined in the demand model _ quantity was found to be pre-determined	Single Equation with Translog Functional Form
Chavas 1983	_developed a method for estimating structural change in U.S. meat demand	_the approach assumed that the parameters could change randomly from one period to the next	1970 - 1979	Poultry Beef Pork	U.S.	_structural change occurred for beef and poultry markets, but not for pork market _the price and income elasticities for beef decreased in the 1970's	Single Equation with Linear Functional Form
Eales *et al.* 1998	_examined the difference between two ways of modeling poultry demand in the U.S. _one approach ignored turkey, the other is to combine turkey and chicken	_in the first approach beef pork and turkey were asymmetrically weakly separable from turkey	1980 - 1996	Poultry Pork Beef	U.S.	_either approach to model poultry demand was appropriate	Rotterdam Demand Model with Logit Functional Form

Kapombe & Colyer 1999	_to provide information would to help encourage exports of chicken products of U.S. origin	_perfect competition _homogeneous products	1970-1993	Chicken	U.S. Japan Hong Kong Canada Mexico	_export markets are more price responsive than the domestic markets _government intervention in the Canadian and Mexican markets reduce their imports _ exchange rate change have a significant impact on the level of exports	Linear Demand System
Reynolds & Goddard 1990	_Examined the structural change in Canadian meat demand.	_no structural change in Canadian meat demand	1968 - 1987	Beef Pork Chicken	Canada	_there is a structural change in Canadian meat demand	AIDS
Wohlgenant 1989	_Provided retail to farm demand linkages for consumer demand and producer supply relationship	_perfect competitive market _the proportions between the farm product and marketing inputs were not fixed	1956-1983	beef pork poultry dairy Fruits	U.S.	_derived demand elasticities that were at least 40% larger compared to those derived assuming fixed proportions	Partial Equilibrium Model with Linear Functional Form
Yang & Koo 1994	_estimated import demand of Japanese meat market _provided reliable estimates of Japanese meat import demand elasticities	_sources of goods were differentiated _the expenditure was treated as an endogenous variable	1973 - 1990	Poultry Beef Pork	Japan U.S. Canada Taiwan EU	_U.S. had the largest potential for beef exports to Japan _Taiwan was in a strong position in the pork market _Thailand and China were strong in the poultry market _the U.S. competes with Canada and Taiwan in the pork market	Source Differentiated Almost Ideal Demand System (SDAIDS)

2.3.2 Farm Supply Model Selection

2.3.2.1 Neoclassical Theory of the Firm

The theory of the firm suggests that firms are concerned primarily with the profit maximizing levels of outputs and inputs. If firms take prices as given in output and factor markets, the profit maximization problem of the firm is stated as:

$$MAX \quad \pi(p_i, w_i) = \sum p_i f(x_i) - \sum c(y_j, w_j) \quad \text{s.t.} \quad MIN \qquad C(y_j, w_j)$$

where p_i is the i^{th} price of output, w_i is the vector of the i^{th} input price, the x_i's are the input factors, and y = f(x) is the production technology function. C is the cost function. The first-order conditions for the profit maximization problem are:

$$\frac{\partial \pi}{\partial x_i} = p_i \frac{\partial f(x_i)}{\partial x_i} - w_j = 0 \quad \Rightarrow \quad \frac{\partial f(x_i)}{\partial x_i} = \frac{w_j}{p_i}$$

Therefore, the factor demand supply functions are:

$$x_i = x_i(p_i, w_i) \quad \text{and} \quad y = f(x_i(p_i, w_j)) = f(p_i, w_j)$$

In a perfectly competitive market, observations on output supply, input prices, and output prices should provide enough information to estimate the supply response of firms.

2.3.2.2 Farm Supply

In general, the expected prices and the cost of inputs affect a producer's decisions about production levels. If a producer expects output prices to be favorable, then this would encourage an increase in production, and vice versa. However, future prices are uncertain, so producers must formulate decisions based on the expected price.

A general approach often used is the partial Adjustment Expectations framework, initially proposed by *Nerlove (1956)*. With this approach, producers use past prices to formulate expectations of the current period prices. The framework is expressed by equations 2.7, 2.8, and 2.9:

$$y_t^* = ax_t + u_t \tag{2.7}$$

$$y_t - y_{t-1} = \gamma\left(y_t^* - y_{t-1}\right) \tag{2.8}$$

$$y_t = a\gamma x_t + (1-\gamma)y_{t-1} + \gamma u_t \tag{2.9}$$

where y_t^* is the optimal level of output during time t, x_t represents a vector of exogenous variables, and y_t is the output during time t. Equation 2.8 represents the adjustment structure, while equation 2.9 is derived by substituting equation 2.7 into equation 2.8.

Another example is the adaptive expectations process. The model uses quantity as a dependent variable and price as an independent variable. Following *Nerlove (1956)*, the model is defined as:

$$P_t^* - P_{t-1}^* = \delta\left(P_t - P_{t-1}^*\right) \tag{2.10}$$

where P_{t-1} is the actual price, P_{t-1}^* is the expected price, and $\delta \in (0,1]$ is a coefficient to be estimated.

The supply function for the current period is defined as:

$$Q_t = \alpha_0 + \alpha_1 P_t^* \tag{2.11}$$

By substituting 2.10 into 2.11 one can get:

$$Q_t = \gamma_0\delta + \gamma_1\delta P_t + (1-\delta)Q_{t-1} \tag{2.12}$$

Thus, current-period supply depends on the actual current-period price and a lagged production variable. In other words, current-period supply is a function of both the

current and past prices. Both the adaptive expectations and partial adjustment models produce the same desired results. The above supply functions are specified based on the theory of the firm, and all of them are modified under the perfectly competitive market.

As introduced in the previous section, the Canadian poultry industry operates under supply management. An implication of supply management is that observed prices are not necessarily relevant in guiding supply decisions. *Moschini and Meilke (1991)* model the supply responses at the farm level with the existence of production quotas. Under this scenario, the farm price level does not affect farm supply. In their study, production quotas can be rented at a price of q_i, and thus the profit function becomes:

$$MAX \quad \pi = \sum (p_i - q_i) f(x_i) - \sum c(w_j, y_j) \text{ s.t. } MIN \quad C(w_j, y_j)$$

where $y = f(x_i)$ is the production function. The supply function is derived from the first order condition:

$$y = \partial\pi / \partial p = y(p_i - q_i, w)$$

Moschini and Meilke (1991) pointed out that it was difficult to estimate the production function directly because the rental price q is typically not observed. They also suggested that one could exploit the duality between profit and cost function and estimate a marginal cost relationship instead of an output price relationship. Therefore, the farm marginal cost should be incorporated in the supply function. The difference between farm price and static quota value equals the marginal cost price.

2.3.2.3 Previous Supply Studies

Many studies have been conducted to examine the Canadian and U.S. poultry supply. Table 2.4 summarizes many of these studies.

Chavas and Johnson (1982) explicitly incorporated the lagged variables into the poultry supply sector. In their framework, the production process was separated into four stages: "placement", "testing", "hatching" and "production". Quarterly data was used in this study. The production process in livestock was viewed in stages, where capital from previous stages was transformed to the next stage by the inclusion of variable inputs at the stage of production. Therefore, the supply of broilers and turkeys were modeled by four equations, which represent the four stages of the production procedure.

First, "Placement" was specified as a partial adjustment model:

$$B1 = f(PB(-2), FC(-2), B1(-4), DV_i, T)$$

In the "testing" function, the lags for broiler placement were expressed as:

$$B2 = f(B1(-2), PBL(-1), FCL(-1), DV_i, T)$$

The third equation was for testing the "hatching" period on farm supply:

$$B3 = f(B2(-1), B2(-2), B2(-3), PBL(-1), FCL(-1), DV_i, T)$$

The last equation for the supply analysis was the production equation:

$$B4 = (B3(-1), PB(-1), FCL(-1), DV_i, T)$$

where B1 = broiler placements in hatchery supply flocks (thousands), B2 = the average number of chickens in flocks tested for pullorum-typhoid (thousands), B3 = the hatching of chicks in commercial hatcheries (thousands), B4 is production (thousand lbs), T = a time trend, PB = the wholesale price of broilers, FC = feed cost, and DV_i = a dummy variable for the *i*th quarter. The variables in this model are the time trend, the output price of broilers, feed cost, and input cost.

Conforti (2001) modeled the supply side of the livestock trade model. He generated the supply side of the partial equilibrium model with four equations:

$$c_i = c(p_{z,j}, p_{z,i}, Polc)$$

$$AL = al(p_{v,i}, p_{v,j})$$

$$r_{z,i} = r(p_{z,i}, AL, TR)$$

$$Qo_{z,i} = c_i \cdot r_{z,i,n}$$

where i, j represent different products, z represents livestock, n is country, p is price, Polc is a policy variable, AL is an index of feed cost, TR is a time trend variable, r is field (per hectare or per head), and Qo_{zj} is total supply of the chicken product.

By substituting the first three equations into the last one, a non-linear supply equation was derived:

$$Qo_{z,i} = c_i(p_{z,j}, p_{z,i}, Polc) \cdot r_{z,i,n}(p_{zj}, p_{v,i}, p_{v,j}, TR)$$

As in previous studies, this retail supply function contains variables for the prices of livestock and other substituting products, and a time trend.

Buhr (1994) developed a quarterly dynamic simulation model of the U.S. livestock sector for both policy analysis and technology assessment. Similar to *Chavas and Johnson (1982)*, this supply equation system consisted of eight equations and five identities. In this system, the supply of feed cost, chicks in hatching flock, broiler, on-farm slaughter and the commercial chicken were analyzed.

Wohlgenant (1989) introduced the complete structural model for a particular commodity, assuming perfect competition in the output and input markets. This model included the retail demand function, retail supply function, farm level demand function, farm level supply function, a retail market-clearing function and a farm level market

Table 2.4 Previous Studies of Supply Analysis

Author	Objectives	Assumptions	Data	Commodity	Country	Conclusions	Model
Bhati 1987	_quantified the effects on the poultry meat sector of a recent change in the domestic feed wheat marketing policy	_homogeneous products _perfectly competitive market	1971-1986	Poultry	Australia	_the feed wheat marketing policy change increased the output and consumption of poultry meat	Linear
Chavas & Johnson 1982	_decomposed the poultry process into stages at which input decisions were made and provides useful information for specifying lag distributions in dynamic supply functions	_homogeneous products _no market power	1965-1975	Chicken Turkey	U.S.	_the supply model matched the poultry biological processes well	Linear
Conforti 2001	_tried to find the characteristics of a partial equilibrium model for simulating the effects of the CAP	N/A	N/A	N/A	EU and ROW	_the five CAP tools benefited the EU producers and improved the level of export volume	Linear
Wohlgenant 1989	_Provided retail to farm demand linkages for consumer demand and producer supply relationships	_perfect competition _the proportions between the farm product and marketing inputs are not fixed	1956-1983	Beef Pork Poultry Dairy Fruits	U.S.	_derived demand elasticities that were at least 40% larger compared to those derived assuming fixed proportions	Partial Equilibrium Model with Linear Functional Form

clearing function. The retail supply (Q_r^s) equation was defined as $Q_r^s = \sum S_r^i (P_r, P_f, W)$, where P_r, P_f, and W were the retail price, the farm price, and the marketing input prices, respectively. The farm-level supply was defined as the input and output lagged prices for farmers.

Many of the studies adopted linear functional forms to analyze the poultry supply with different explanatory variables. Even though explanatory variables differ by study, most of them included the retail price, feed cost, input and output prices, and government intervention.

2.3.2.4 Summary

The theory of the firm suggests that input demand and output supply functions can be derived via profit maximization. The farm supply functions adopted in the previous studies have prices of live birds, feed cost, lagged production, and time trend. Linear functional forms were adopted by most of the previous studies. In the current study, because of supply management, Canadian farm supply is determined by farm marginal cost instead of farm prices. In addition, a time trend can be included in the model to evaluate the production technology change. Therefore, the Canadian farm supply function is modeled as a function of farm marginal cost (difference between farm price and production quota price), feed cost, lagged production at farm level, and time trend. The U.S. and EU farm supply functions are modeled as functions of farm prices, feed costs, lagged production at the farm level, and a time trend, as in previous studies. A linear functional form is adopted for all of the regional models.

2.3.3 Processor Demand Model Selection

As discussed in the previous section, firms are concerned with the profit maximizing levels of outputs and inputs. Based on the theory of the firm, the input demand and output supply functions are derived. The poultry-processing sector needs live birds and non-farm inputs (labour, capital, and managerial skill) to produce poultry meat. As such, poultry processors provide the transformation from the live birds to table-ready. *Appelbaum (1982)* raised concerns of market power founded on this production behaviour. In the current study, poultry industries in Canada, the U.S. and the EU need to be analyzed while incorporating imperfect behaviour. Therefore, market power will be imposed and tested in these three countries' regional models.

2.3.3.1 Market Power Theory and Previous Related Studies

A lot of research has been done on estimating market power in the agricultural sector. Most of this research is derived from a standard framework developed by *Appelbaum (1982)*. Since many of the studies have followed this work, it is useful to review *Applelbaum's* conjectural elasticity model.

Appelbaum (1982) outlined an industry under an imperfectly competitive structure. It was assumed that individual firms can affect price through their output level but not affect input prices — i.e., firms have oligopoly, but not oligopsony power. Consider an industry that consists of N firms producing homogeneous products X. The j^{th} firm's profit maximization decision is described as:

$$Max \prod_j = PX_j - C_j(X_j W_j) \quad \text{s.t.} \quad P = h(X, Z) \quad \& \quad X = \sum_{j=1}^{N} X_j$$

where P is output price, X is the total industry output, X_j is the jth firms' output; $C_j(\cdot)$ is the j^{th} firm's cost function, W_j is the j^{th} firm's input price, and Z_1 is a vector of exogenous variables affecting demand. The firm's first order necessary condition for profit maximization is:

$$\frac{\partial \pi_j}{\partial X_j} = P + \frac{\partial P}{\partial X_j} \cdot X_j - \frac{\partial C_j(W_j \cdot X_j)}{\partial X_j} = 0 \qquad (2.13)$$

In a perfectly competitive market, it is assumed that firms cannot affect the market price, so $\partial P / \partial X_j = 0$. If market power exists, individual firms are able to affect price through their output decision, meaning $\partial P / \partial X_j \neq 0$.

Equation 2.13 can also be written as:

$$MC_j(1 + \frac{\theta_j}{\eta_j}) = P$$

where θ_j is the j^{th} firm's conjectural variations elasticity, and η_j is the j^{th} firm's price elasticity of demand. From this function, *Appelbaum (1982)* derived the Lerner Index: L. It measures the percentage difference between price and marginal cost as:

$$L = \frac{P - MC_j}{P} = \frac{\theta_j}{\eta_j}$$

L measures the degree of price-influencing behaviour relative to perfect competition. If $\theta = 0$, then the industry is perfectly competitive, but if $\theta = 1$, then the industry is classified as a monopoly. If θ is between 0 and 1, then the industry can be characterized as an oligopoly.

Fulton and Tang (1999) examined whether market power exists in the Canadian chicken industry, using *Holloway's (1991)* model. With Holloway's method, θ is not

estimated as a function, but is instead included in the simultaneous model as a parameter. The results indicate that market power exists in the chicken retailing and processing sectors, since θ is tested to be significantly different from zero.

Cranfield (1995) examined the oligopoly power in the Canadian food processing industry, following the framework of *Appelbaum (1982),* which began with a Generalized Leontief cost function:

$$C = \sum_i \beta_i \cdot w_i + \sum_i \sum_j \beta_{ij} \cdot (w_i \cdot w_j)^{1/2} \cdot X$$

where β_i, β_{ij} = parameters to be estimated, w_{ii} = inputs per unit cost, X = the output at the firm level, and K, L, and M = capital, labour, and raw materials, respectively.

Applying Shepherd's Lemma to the industry cost function $C_j = C_j(X_j, W_j)$, one can find the input demand functions:

$$\frac{X_i}{X} = \frac{\beta_i}{X} + \beta_{ij} + \sum_j \beta_{ij} \cdot \left(\frac{w_j}{w_i}\right)^{1/2}$$

The input demand function can be expressed as a function of input prices and output quantities. With the market power concern, the price in general is defined as:

$$P = MC - \frac{\theta}{\eta}$$

After substituting the equation for marginal cost derived from Generalized Leontief cost function, the price equation becomes:

$$P = \sum_i \sum_j \beta_{ij} \cdot (w_i \cdot w_j)^{1/2} - \frac{\theta}{\eta}$$

where η is the retail demand elasticity. Since P is observed, and η and β are parametric estimates, this equation allows for a parametric estimation of θ. In Cranfield's study, θ

was specified as a structural equation, which was a function of a relevant Herfindahl Index (used to measure industry concentration), a time trend, and a dummy variable representing the introduction of supply management in the Canadian dairy and poultry production sectors. Then, the function of price becomes:

$$P = \sum_i \sum_j \beta_{ij} \cdot \left(w_i \cdot w_j\right)^{1/2} - \frac{\alpha_0 + \beta_{SM} \cdot SMD + \beta_H HFINDX + \beta_T \cdot TR}{v}$$

where α and β are parameters to be estimated, SMD is a supply management dummy variable (equal to 0 for the years 1965 to 1975, and 1 for 1976 to 1990), HFINDX is the Herfindahl Index, and TR is a time trend.

Appelbaum (1982) specified θ to be a function of the exogenous input prices, while *Lopez (1984)* specified it as a function of industry concentration and a time trend. In the current study, the best explainable variables in θ equations will be tested and chosen, these variables include number of firms, time trend, input prices and net trade. A supply management dummy variable is not included in this study, because the whole estimation period is under supply management.

2.3.3.2 Market Power in Canadian Poultry Industry

In Canada, there is poultry production within every province, where the provinces can be categorized into 3 regions: Western Canada (British Columbia, Alberta, Saskatchewan, Manitoba), Central Canada (Ontario, Quebec), and Eastern Canada (New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland). The level of production within each region conforms closely to the population levels within those regions at 30%, 62% and 8%, respectively. Production concentration in Canada can be contrasted to

production in the United States, which is situated mainly in the southeastern states *(Agriculture and Agri-Food Canada and Market and Industry Services Branch, 1999)*.

In Canada, there are 135 primary poultry processing plants (63 federally inspected and 72 provincially inspected). The five largest companies, Flamingo Foods, Group Dorchester/St. Damase, Lilydale Poultry Cooperative, Maple Leaf Poultry, and Maple Lodge Farms account for fifty percent of poultry slaughtered in Canada *(Agriculture and Agri-Food Canada and Market and Industry Services Branch, 1999)*. When looking at individual plants, eighty percent of the production is done by twenty-two percent of the plants.

Economic theory suggests the industry concentration may increase a firm's market power since firms have the ability to influence the market price. The above information suggests there is a strong possibility that the poultry industry does have some degree of market power in its processing sector. Some studies (*Lopez, 1984*; *Cranfield, 1995*; *Fulton and Tang, 1999*) examined if there was market power in the Canadian poultry industry. Both *Lopez (1984)* and *Cranfield (1995)* suggested that there is oligopoly power in the Canadian food processing industry. *Cranfield (1995)* found there is market power in the poultry sector. The related studies are summarized in Table 2.5.

2.3.3.3 Market Power in the U.S. Poultry Industry

The United States is the world's largest producer of poultry meat. In 2001, poultry meat production in the U.S. totaled 22,025 metric tons. However, as poultry meat output increased rapidly, the number of individual poultry producers declined significantly, and the size of the remaining firms increased. The number of firms producing poultry meat

dropped nearly a third between 1959 and 1988. In the U.S., the large leading poultry companies account for most of the output. For example, the 20 largest broiler companies controlled about 78 percent of total production in 1988. The poultry industry became increasingly concentrated between 1977 and 1987, and remained constant thereafter (*Ollinger et al. 2000*). This means the concentration of the poultry industry in the U.S. is still quite high today.

Many studies have been conducted to examine market power in the U.S. meat industry. *Paul and Catherine (1999)* examined if there was market power in the U.S. meat and poultry industry with a flexible cost function. Their results suggest some evidence of market power. They also examined scale economies and market power in the U.S. meat packing industry. The measures reported in his study indicate significant but declining market power in the U.S. meat packing industry during 1970-1991.

Azzam and Pagoulatos (1990) analyzed the imperfections in output and factor markets of the U.S. meat-packaging industry. The estimation of the simultaneous-equation model consisted of a production function and the first-order conditions of it. The results suggest that the industry exercises market power in both the output (meat) and the factor (live animal) market.

A number of studies concerning market power in the Canadian and U.S. meat or poultry processing sectors are summarized in Table 2.5. Many of these studies followed *Appelbaum's (1982)* methods. The underlying assumption is constant return to scale (CRS) technology. Constant return to scale in production means the output increase has to match the same percentage increase in total inputs. The CRS technology is appropriate to the poultry industry since the proportion of the ready to cook meat can be taken from

live birds is almost stable. According to the results of these studies, there is a strong possibility that oligopoly power exists in the U.S. and Canadian meat sectors.

No previous studies have shown that market power exists in the EU poultry industry. However, the number of firms in the EU chicken industry has been decreasing during the past 15 years. This may imply that the EU chicken industry concentration rate is higher than in the past. Therefore, the market power of this industry needs to be examined as well. In this dissertation, market power is assumed to exist in the U.S. and Canadian poultry industries, as well as the EU chicken market. The degree of market power is measured by the methodology developed by *Appelbaum (1982)*.

There are few studies indicating market power in the poultry industry in Brazil, China, Japan, Russia and Mexico. Given the lack of such studies, as well as data limitations, a perfectly competitive market structure is assumed for these countries' poultry industries.

2.3.4 Summary

In this section, previous studies that account for consumer, processor and farmer actions in the Canadian and other major competitive countries' poultry industries have been discussed. The market structure of the Canadian poultry industry is analyzed with supply management. In the current study, oligopoly power is assumed to exist in the Canadian and U.S. poultry industries, as well as the EU chicken industry. All of the above is based on past studies related to this research area.

Table 2.5 Previous Market Power Studies

Author	Objectives	Assumptions	Data	Commodity	Country	Conclusions	Model
Azzam & Pagoulatos 1990	_analyzed the industry's oligopoly and oligopsony market power	_homogeneous output _constant return to scale	1972-1982	Meat	U.S.	_industry exercised market power in both the output (meat) market and the factor (live animal) market	Translog Production Function
Paulm & Catherine 1999	_examined the market power in the Input (livestock) and output (meat product) industries	_homogeneous products	1970-1991	Beef Pork Poultry	U.S.	_market power was found to exist in the beef, pork, and poultry industry	Translog Production Function
Cranfield *et al.* 1995	_measured the degree of oligopoly power in the Canadian food processing industry	_different market power measures for different industries _homogeneous output	1965-1981	Dairy Vegetable Poultry Red meat	Canada	_significant oligopoly power was found in these industries	Generalized Leontief Cost Function
Fulton & Tang 1999	_checked if there was market power in both producer and retail sectors in the Canadian chicken industry	_symmetric equilibrium implying that the processing firms are identical	1965-1985	Poultry	Canada	_market power at either or both the processing or retailing level resulted in higher retail prices	Cost Function
Lopez 1984	_measured the factor demand response and other production characteristics of the food processing industry in Canada	_non-competitive market	1965-1979	Food Processing Sector	Canada	_the food processing industry was not characterized by price-taking behaviour _there was some degree of market power in Canadian food processing industry	Generalized Leontief Cost Function

2.4 Welfare Analysis

2.4.1 Consumer Welfare Measurement

There are three money metric measures of welfare: Consumer Surplus (CS), Compensating Variation (CV) and Equivalent Variation (EV). CS is the difference between the consumers' valuation of a product and what they actually pay for it (*Nicholson 1992*). EV uses the current price as the base and asks what income change at current prices would be equivalent to the proposed price change in terms of its impact on utility (*Varian, 1992*). CV uses the new price as the base and asks what income change would be necessary to compensate the consumer for the price change (*Varian, 1992*). CS is based on the Marshallian or uncompensated demand curves, whereas EV and CV are based on Hicksian, or compensated demand curves. Therefore, CV and EV reflect pure substitution effects, while CS reflects both substitution and income effects *(Cranfield, 1995).* Therefore, in the current study CS is chosen to estimate consumer welfare.

2.4.2 Producer Surplus Measurement

Producer surplus is defined as the return to fixed factors of production. It is the area below price and above the supply curve. Producer surplus is closely related to the profits of a firm which equals revenues minus variable costs, or equivalently, profits plus fixed costs:

$$\textit{Producer's surplus} = py - c(y)$$

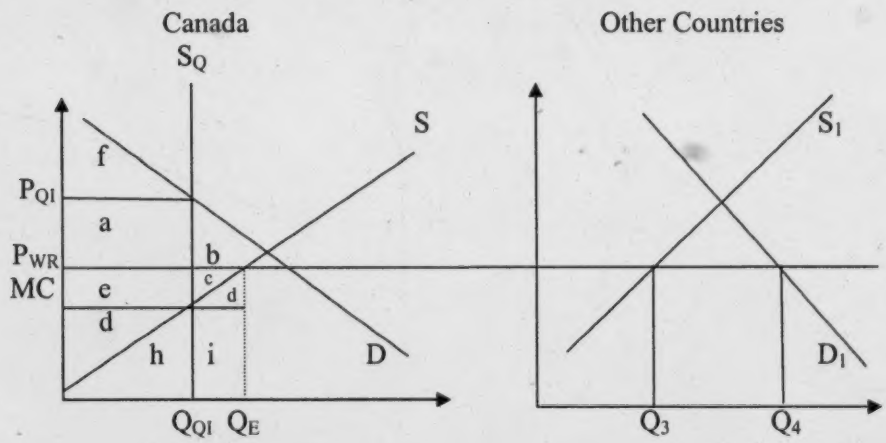
where p is the price of production, and c(y) is the cost function of the firm. A change in producer surplus happens when firms change their output level. In the current study, exports of poultry could change the total poultry supply both at the farm and processor

level[1]. Therefore, trade flows have an impact on the main trading countries' producer surplus, and this impact needs to be estimated.

2.4.3 Welfare Effects of Supply Management

Economists examined the effects of supply management on the competitive nature of markets through welfare analyses (*Veeman, 1988*; *Beck et al. 1994*; *Babula and Romain, 1991*; *Moschini and Meilke, 1991*). These studies provide essential ideas of how supply management affects the consumer, processor and producer welfare.

Figure 2.3 Consumer and Processor Welfare Effect of Supply Management



Under supply management, the domestic market equilibrium point is at P_{QI} and Q_{QI} (see Figure 2.3). The international market equilibrium price in Canada is at P_{WR}, and Q_E-Q_{QI} is the volume of Canadian exports. Without exports, the total processor revenue is P_{QI}*Q_{QI}, which is the area a+e+d+h. The processor profit area is area a+e. If exports are included, then the total revenue of the processor changes to Q_{QI}*P_{QI}+(Q_E-Q_{QI})*P_{WR}, which is the area a+e+d+h+c+d+i. Furthermore, processor profits increase to a+e+c+d.

[1] To distinguish the welfare analysis between farmers and processors, producer surplus is used to represent the welfare at farm level and processor profits to represent the welfare at processor level.

For consumers, if there is no export, then consumer surplus is equal to f under supply management. If exports are not included, then consumer surplus doesn't change because the domestic price and consumption do not change.

2.4.4 Previous Studies of Supply Management

Veeman (1988) applied a traditional welfare-triangle analysis in her study to determine the social cost effects of the national supply management program on the poultry market. Her results suggest that current producers had benefited from significantly higher and more stable prices and gross incomes, as well as the capital gains of quota value appreciation. The producers have benefited from the expenditures of the consumers even though consumption levels had been reduced.

Kooten and Spring (1984) analyzed the welfare impacts of supply-restricting marketing boards. In the first part of their study, a conventional comparative static analysis was used to describe the appropriate welfare measures for a perfectly competitive industry in both the short- and long-run scenarios. This analysis was described in a supply and demand diagram. In the second part of the paper, the long-run measure was used to estimate the income transfers, rents and allocative efficiency losses. Comparing the two estimations of *Veeman*, and *Kooten and Spring*, the measures of consumer welfare loss by the latter's study are smaller than those obtained by *Veeman*.

Beck et al. (1994) evaluated the welfare loss from egg and poultry marketing boards with a similar methodology. The authors used a model that combined the traditional welfare triangle with the social welfare loss created when farmers bear the investment risk associated with the possible termination of quota protection. The results

showed that the annual net social-welfare loss from the egg and poultry marketing board likely exceeds $100 million, with consumers losing more than $500 million.

Furthermore, *Kooten (1988)* measured the consumer welfare loss under the supply-restricting marketing boards in Canada. Alternative approaches from the studies cited were compared. The results suggest that the use of CV and EV may provide an approximation of the true measures of consumer welfare. It was estimated that consumers probably lost between CDN$1.01 and CDN$1.14 for every CDN$1 transferred to producers as a result of marketing boards in poultry products and eggs.

Schmitz and Schmitz (1994) summarized many of the previous studies related to supply management in the Canadian dairy and poultry sectors in their study "Supply Management: The Past and Future". In their paper, certain theoretical aspects were discussed, including import quota restrictions, the cost of production pricing and quota values, inter-provincial trade, contracts and vertical linkages. The conclusion indicated that producers were better off with supply management than with a system of no production controls.

Moschini and Meilke (1991) illustrated how to model the supply response of supply-managed industries. In this study, two modeling methods were introduced. First, if the rental price of quotas was available, then one could compute the administered price of supply-managed commodities. This price could be used to estimate the inverse supply response functions and input demand functions. Alternatively, one could rely on supply responsiveness (through a profit function approach). In the latter case, the departure from marginal cost pricing was obtained by appropriately discounting observed quota values.

Some studies were conducted to examine the supply management effect on poultry consumer, processor and producer welfare. *Huff et al. (2000)* compared the price and trade competitiveness of the Canadian chicken market in the late 1990's with the situation in the late 1980's. Their results suggested that Canadian chicken producers had become far more price competitive since the implementation of the Uruguay Round Agreement on Agriculture than they were in the 1980's. The over-quota tariff rate for Canadian chicken meat was 280% in 1990 and fell to 238% in 2001. The over-quota tariff was about ten times greater than the true tariff equivalent. However, the Canadian chicken industry would be unaffected by cutting to this over-quota tariff unless the Canadian industry was perfectly competitive without supply management.

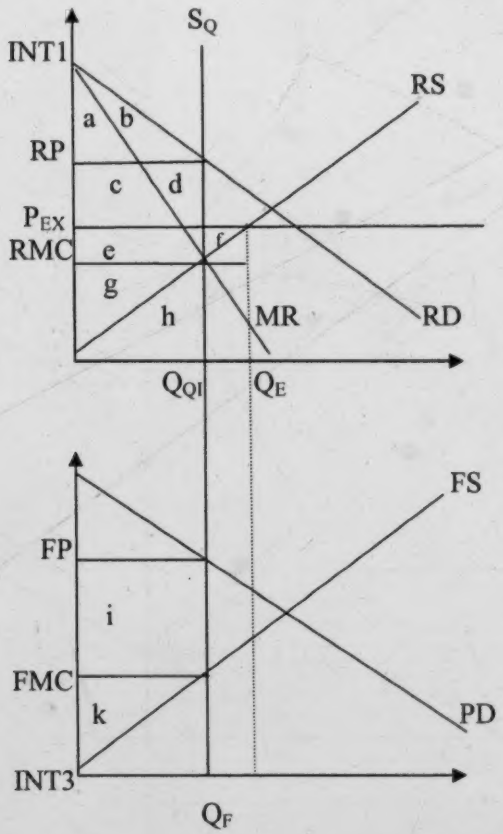
Babula and Romain (1991) examined the effect of Canada's broiler supply management on the U.S. broiler price. The author used Vector Autoregression (VAR) techniques to glean empirical regularities from monthly data on four broiler prices: U.S retail and farm prices, and Canadian retail and farm prices. Evidence suggested that current Canadian broiler prices were less responsive to U.S. broiler price movements, when compared to the period preceding Canada's national broiler supply management program. The Canadian supply management programs had been successfully blocking the price transmissions through the four U.S.-Canadian broiler price linkages.

Schmitz (1983) reviewed both the methodology and the empirical results of previous supply management studies. The major focus was on certain Canadian supply-managed markets: dairy, eggs, broilers and turkeys. The author found that there was a sizeable income transfer from consumers to producers along with a misallocation of resources as a result of supply management.

The above studies give a general idea of how to model the supply curve of the model under supply management. Among them, *Veeman (1988)*, *Kooten and Spring (1984)* and *Cranfield (1995)* adopted the money metric approaches to estimate the changes in consumer, processor and producer welfare.

2.4.5 Canadian Consumer Surplus, Producer Surplus and Welfare Measurement

Figure 2.4 Welfare Analysis of the Canadian Poultry Market



where RP = domestic retail price
RMC = retail marginal cost
RS = retail supply
RD = retail demand
FS = farm supply
PD = processor demand
INT = intersection
FMC = farm marginal cost
P_{EX} = export price

In the current study, the change in consumer surplus due to the impact of government policies will be measured by money metric approaches. The consumer surplus is the area above the retail price and below the retail demand, or $a+b$ in Figure 2.4. It can be calculated based on the retail demand function. The intersection of retail

demand and the vertical line equals INT1. Thus, the Canadian consumer surplus equals $0.5*(INT1-RP)*Q_{QI}$.

For processors, the marginal cost difference provides a per-unit measure of processor profit when marginal costs are constant. Multiplying this margin by quantities of poultry produced by processors provides a measure of profits. Without exports, the processor profits is the price of the poultry products multiplied by domestic consumption ($RP*Q_{QI}$), which is the area *c+d+e*. After exports, the total revenue of the producers changed to *c+d+e+f*. Since the RMC represents marginal cost, the processor profits can be calculated by the function $(RP-RMC)*Q_{QI} + (P_{EX}-RMC)*(Q_E-Q_{QI})$.

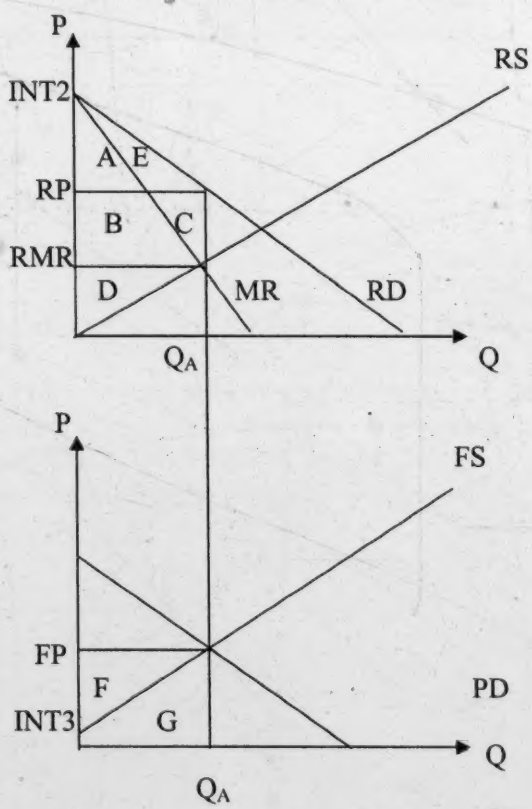
Producer surplus is used to determine the monetary impact of changing policies on the farmers. Producers' surplus can be defined as: $PS = FP*Q_F - \int_0^Q FP^{FS}(Q)d(Q)$, where FP is the farm price, Q is the quantity supplied, and FP^{FS} is the farm supply function. Without supply management, Canadian poultry producer surplus is the area under farm price and above the farm supply. With supply management, farmers have to pay the quota values, which equal FP-FMC. Therefore, the producer surplus is the area *k*. This area can be calculated by the function $0.5*(FMC-INT3)*Q_F$.

2.4.6 The U.S. and EU Consumer Surplus, Producer Surplus and Processor Profits

In the U.S. and EU, there is no supply management, but oligopoly market power may still exist. The U.S. and EU are exporting poultry products at world price levels, which are the domestic prices minus the export subsidies. However, the U.S. and EU governments pay export subsidies, not processors and producers. Therefore, firms get the same profits in both domestic and international markets. With oligopoly market power

the market equilibrium point is at the retail price RP and the total demand Q_A in Figure 2.5. The consumer surplus is area A+E. Therefore, the U.S. and EU countries' consumer surplus is equal to 0.5*(INT2-RP)*Q_A. The U.S. and EU processor profits in the domestic market is shown by the area B+C, or by the function (RP-RMR)*Q_A. The U.S. and EU poultry producer (farmer) surplus is the area of F. Therefore, the U.S. and EU producer (farmer) surplus are calculated by: 0.5*(FP-INT3)*Q_A.

Figure 2.5 Welfare Analysis of the U.S. and EU Poultry Market



where RP = domestic retail price
RMR = retail marginal revenue
RS = retail supply
RD = retail demand
FS = farm supply
PD = processor demand
INT = intersection

2.5 Summary

In this chapter, a conceptual framework has been developed that accounts for consumer, processor and farmer actions in the Canadian and other major countries' (regions') chicken (turkey) industries.

Based on the literature review, oligopoly power was assumed to exist in the Canadian and U.S. poultry and EU chicken industries. A perfectly competitive market structure was assumed in all other regions such as Brazil, Russia, Mexico, Japan, and China. An econometric partial equilibrium model, instead of an economy-wild model was chosen for this research purpose. The supply and demand sides of the model were specified. In addition, cost and benefit measures for consumers, processors, and producers were discussed. The next chapter focuses on the model structure and a discussion of the data.

CHAPTER 3

MODEL STRUCTURE AND DATA

Based on the review of previous studies, the poultry trade model is developed and reviewed in this chapter. In the first section, regional models for major poultry trading countries are specified. Each regional model is specified based on the market structure and policy factors of that particular country. The second part of this chapter describes the data used and the sources. In the third part, trade, production and price data across countries are compared and discussed. The last section presents discussions of statistical tests used in the model.

3.1 Model Structure

3.1.1 Chicken and Turkey Trade Countries Selection

Chicken and turkey products are modeled separately in this study. Regional models are built for the main chicken and turkey trading countries. These countries are selected based on the data. For the chicken market, the top three chicken exporting countries are the U.S., EU, and Brazil. In the current study, Canada is also included as one of the exporting countries. These countries are expected to dominate export markets due to the availability of supplies and price competitiveness. According to the data, Russia, China and Japan the major chicken importing countries in the world market (Table 3.1).

The turkey market is not as large as the market for chicken. In 2001, the total volume of turkey products exported were 610 thousand metric tons, which was approximately 13.89% of the total chicken exports by quantity. There are some

differences between chicken and turkey international markets. For example, Canada is a net exporter for turkey products whereas some Asian countries such as China and Japan are not active in the international turkey market (Table 3.2). In addition, the U.S. has no turkey imports at all. Based on the data, the U.S., EU, Canada and Brazil are the main exporters, while Mexico and Russia are selected as importers.

Table 3.1 Total Broiler Meat Exports and Imports for Selected Countries (1,000 Metric Tons)

Exports	***1998***	***1999***	***2000***	***2001***
U.S.	1,978	2,080	2,231	2,521
EU	788	764	762	718
Brazil	594	750	893	1,241
China	323	375	464	489
Canada	53	47	55	69
Thailand	274	288	328	425
Hungary	52	45	35	35
Others	134	113	100	109
Total	4,196	4,462	4,868	5,607
Imports	***1998***	***1999***	***2000***	***2001***
Russia	1,020	930	943	1,281
Japan	590	667	721	710
China	427	591	608	473
Hong Kong	269	391	239	234
Mexico	181	188	219	235
Saudi Arabia	287	364	348	399
Others	781	855	951	1,059
Total	3,555	3,986	4,029	4,391

(Source: USDA, Production, Supply, and Distribution Database, 2003)

3.1.2 EU, Russia, Brazil, China and Japan Import Demand or Export Supply

In the current study, a perfectly competitive market structure is assumed for the poultry markets of Mexico, Brazil, Russia, China and Japan. As discussed in the previous section, these countries' trade models focus on only one market level. Therefore, only the import demand functions for Russia, Japan, China, and Mexico, and the export supply functions for Brazil and the EU need to be estimated. Traditionally, import demand is

modeled as a function of world price, real income, and dummy variables to account for unusual periods such as devaluations or policy changes (*Kahn, 1975*; *Boylan and Cuddy, 1987*). The relative price measure is often the ratio of the import price to the domestic price index for the commodity adjusted for the exchange rate, which gives a measure of the real exchange rate (*Kahn, 1975*; *Boylan and Cuddy, 1987*). Lagged import (export) quantity variables can also be included to capture the influence of previous period imports (exports) on the current period's trade. In addition, a time trend can be included to examine trade activity changes of main exporters (importers) during the estimation period. In general, the export supply of a good is a function of the good's export price, exchange rate, time trend, product capacity and supply stocks. The import demand of a good is a function of the good's import price, exchange rate, policy variables, time trend, and lagged dependent variables (Table 3.3).

Table 3.2 Total Turkey Meat Exports and Imports for Selected Country (1,000 Metric Tons)

Exports	***1998***	***1999***	***2000***	***2001***
U.S.	202	172	202	221
EU	209	234	248	261
Brazil	20	26	44	69
Canada	10	10	14	10
Hungary	20	25	26	24
Others	17	25	28	25
Total	478	492	562	610
Imports	***1998***	***1999***	***2000***	***2001***
Russia	147	161	163	164
Mexico	130	143	159	171
EU	35	44	61	86
Canada	4	5	4	5
Others	66	96	86	74
Total	382	449	473	500

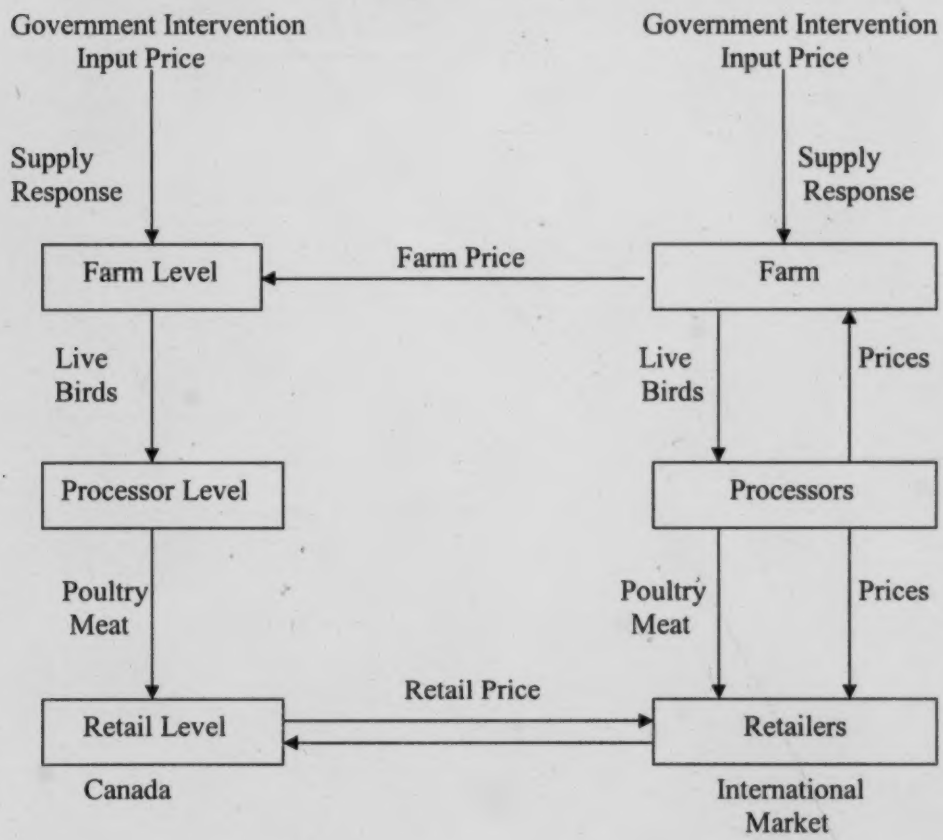
(Source: USDA, Production, Supply, and Distribution Database, 2003)

Table 3.3 Equations and Variables for Competitive Poultry Industries

Import Demand Function for Russia, Mexico, Japan and China: ID = f (WP, INCOME, ER, PL, TIME, ID-1) Export Supply Function for Brazil and EU: ES = f (WP, ER, TIME, PL, ES-1)	Endogenous Variables: ID = import demand for poultry WP = world price for poultry ES = export supply for poultry Exogenous Variables: ER = exchange rate PL = policy variables such as tariff TIME = time trend

3.1.3 Canadian Poultry Industry Model

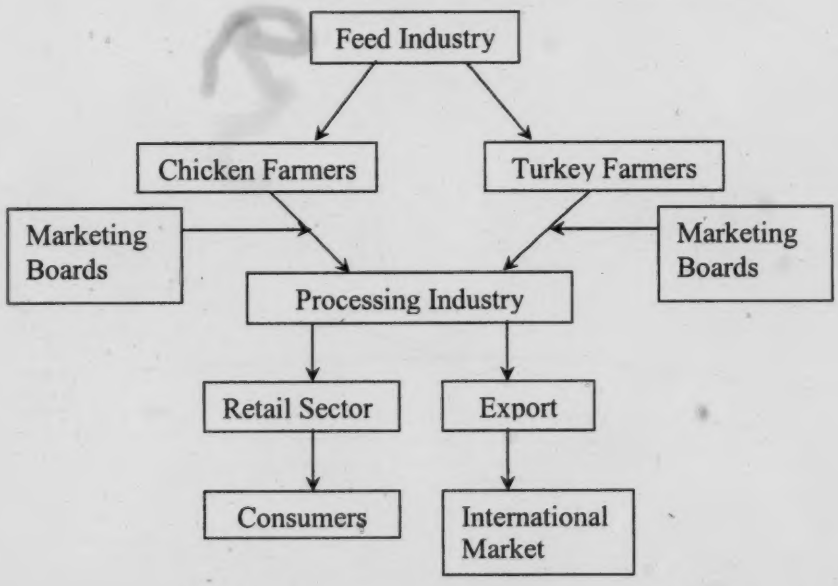
Figure 3.1 Canadian Poultry Industry in the World Poultry Market



The structure of the Canadian model is presented in Figure 3.1. Different market levels of the Canadian poultry industry, including farm, processor and retail levels, are presented in the boxes. The arrows describe how the different markets can be impacted from diverse directions of effects. This figure suggests that if there is no supply management and market power does not exist in the Canadian poultry industry, then Canadian poultry retail prices be jointly determined by its domestic and international markets. However, with oligopoly market power and supply management poultry production, demand and prices are affected by the behaviour of both marketing boards and firms.

3.1.4 Canadian Domestic Market Structure

Figure 3.2 Canadian Poultry Industry Flow Chart



The Canadian domestic poultry market consists of input suppliers (such as feed companies), poultry producers (chicken and turkey farmers), poultry processors (live

birds processing), and the international trade sector (Figure 3.2). Except for commercial entities (farmers, processors, retailers), the marketing boards are involved in making the decisions. As discussed in the previous section, the Canadian poultry industry operates under supply management. The Chicken Farmers of Canada (CFC), the Canadian Turkey Marketing Agency (CTMA) and the corresponding provincial boards affect the market between farming and processing.

3.1.5 Modeling Canadian Poultry Industry with Supply Management and Market Power

In this section, the Canadian poultry industry is modeled under supply management. In this modeling framework, two market levels are considered (i.e., retail and processor levels), and oligopoly power is assumed to exist. To model the Canadian poultry industry, retail demand, farm supply, processor demand and market power functions must be specified.

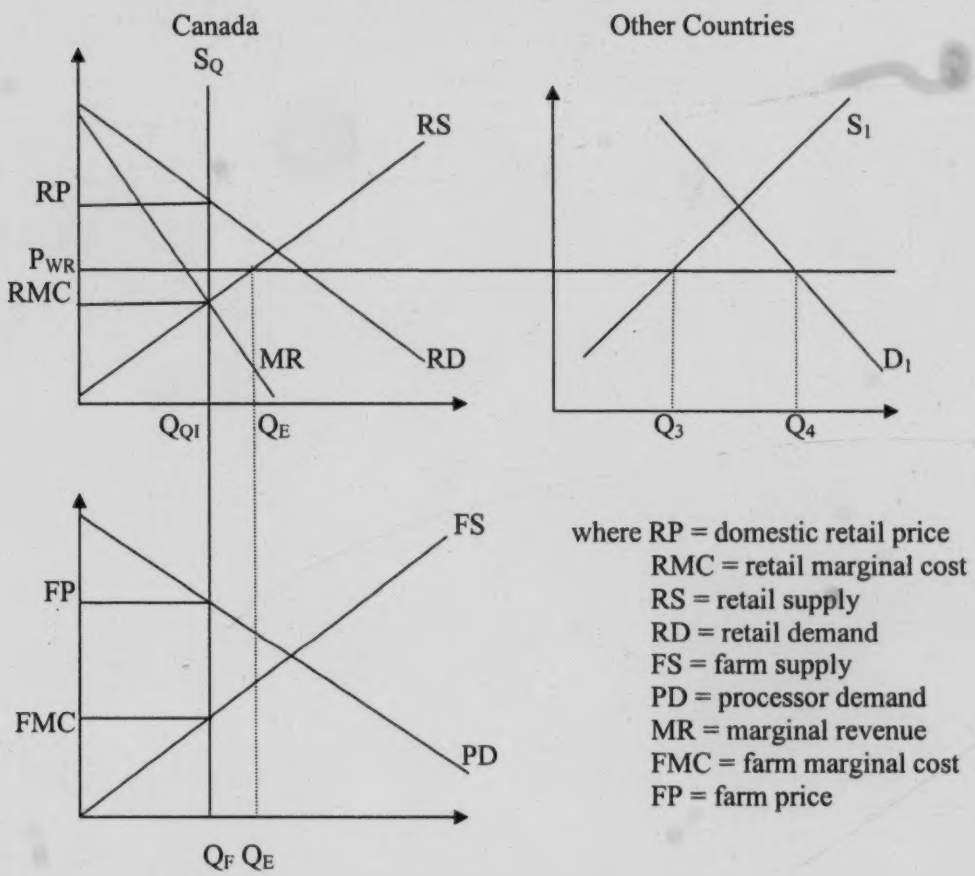
Figure 3.3 shows the relationships between prices, supply and demand for the Canadian poultry industry. As discussed in Chapter 2, retail chicken (turkey) demand is a function of the prices of chicken (turkey), beef and pork income and a composite price index (Equation 3.1). The prices and income in the economy are all converted into real terms using the CPI (consumer price index) as deflator. This imposes homogeneity of degree zero in prices and income as a maintained hypothesis. In addition, time is another variable used to capture the trend in consumer preferences (see Table 3.4 for the variable definitions).

$$RD_{PT} = \beta_{11} + \beta_{12} RP_{PT} + \beta_{13} RP_{B} + \beta_{14} RP_{PK} + \beta_{15} INC + \beta_{16} * TIME \qquad (3.1)$$

In the current study, fixed proportion technology is assumed. Therefore the retail supply function is the processor (input) demand function multiplied by a conversion factor. This conversion factor is the carcass weight, which can be derived from live birds. As discussed in Chapter 2, with supply management the recorded farm price cannot be used to estimate supply parameters. Farm production supply (Q_{QI} in Figure 3.3) is based on market demand at the cost of production price (FMC). The difference between FP and FMC is equal to the static quota value. In addition, feed cost and a time trend can also be introduced to the farm supply function.

$$FS = \alpha_3 + \beta_{31} FMC + \beta_{32} WFC_{PT} + \beta_{33} FS_{PT}(-1) + \beta_{34} TIME \qquad (3.2)$$

Figure 3.3 Canadian Poultry Market Under Supply Management



The input demand function is derived from a Generalized Leontief cost function, which follows the framework of *Appelbaum (1982)* (see Section 2.3.3.1). It is modeled as a function of the Canadian farm price and other input prices (labour, utility, etc.) at the processor level, as follows:

$$PD_{PT} = \frac{\partial C}{\partial w_i} = \beta_i + (\sum_i \sum_j \beta_{ij} (w_i w_j)^{1/2} + \beta_{ii}) \cdot RD_{PT} \tag{3.3}$$

The equation applied to measure market power is:

$$RP_{PT}(1 - \theta / \eta) = RMC \tag{3.4}$$

since RP_{PT} is used as the output (retail) price, and marginal cost is from the processing industry, which implies poultry processors and retailers are assumed to be in the same industry. η is the absolute value of the retail demand elasticity, and RMC function is derived from the Generalized Leontief cost function and included in equation 3.3. Thus, the market power equation becomes:

$$RP = \sum_{i=1} \sum_{j=1} \beta_{ij} \cdot (w_i \cdot w_j)^{1/2} / \frac{\theta}{\eta} \tag{3.5}$$

As introduced in Chapter 2, θ is modeled as a function of net trade (Nettrade), the relevant Herfindahl Index (or number of firms, HFINDX) and a time trend.

$$\theta = \gamma_0 + \beta_{SM} * Nettrade + \beta_H * HFINDX + \beta_T * TIME \tag{3.6}$$

Substituting equation 3.6 into 3.5 gives the market power equation:

$$RP = \sum_{i=1} \sum_{j=1} \beta_{ij} \cdot (w_i \cdot w_j)^{1/2} / (\frac{\gamma_0 + \beta_{SM} Nettrade + \beta_H HFINDX + \beta_T TIME}{\eta}) \tag{3.7}$$

Aside from the above equations, there are some identities that are required for closing this model. First, the quota value is equal to the difference between farm price and farm marginal cost.

$$QV = FP_{PT} - FMC_{PT}$$

Second, the farm supply is assumed to equal the producer demand because only trade in the retail sector is considered in the current study.

$$FS_{PT} = PD_{PT}$$

For allowing the estimation of international trade flows, the market equilibrium linkage for Canada is that retail supply equals the retail demand plus net exports:

$$RS_{PT} = RD_{PT} + EX_{PT} - IM_{PT}$$

Based on the above discussion, the chicken and turkey models for Canada are summarized in Table 3.4.

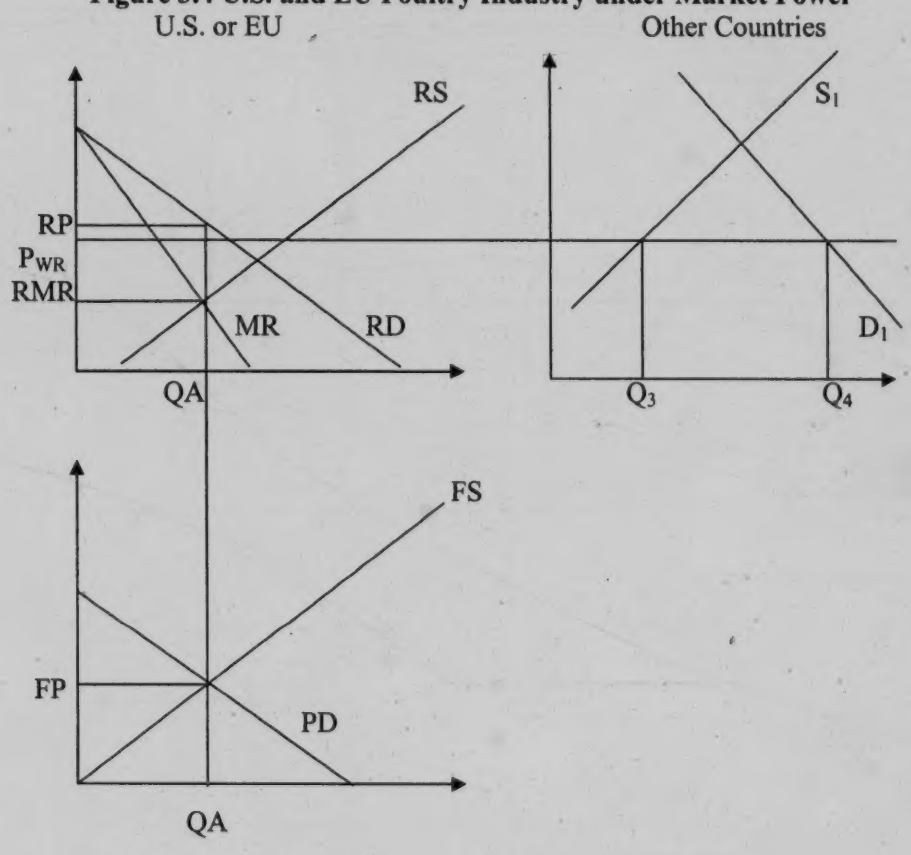
Table 3.4 Table of Modeling Canadian Poultry

Consumer Demand $RD_{PT} = f(RP_{PT}, RP_B, RP_{PK}, I)$ Processor Demand $PD_{PT} = f(FP_{PT}, RMC_{PT}, W_i)$ Farm Supply $FS_{PT} = f(FMC_{PT}, W_i)$ Oligopoly Power $RP_{PT} = RP_{PT} = RMC_{PT} \cdot (1 - \theta/\eta)$ Quota Value $QV = FP_{PT} - FMC_{PT}$ Market Equilibrium linkage $FS_{PT} = PD_{PT}$ $RS_{PT} = (RD_{PT} + EX - IM)/Conv$ Market Power Equation $RP_{PT} = RMC_{PT}*(1-\theta/\eta)$ $\eta = -(\partial RD_{PT} / \partial RP_{PT})(RP_{PT} / RD_{PT}), \eta > 0$	**Endogenous Variables** RD = domestic retail demand for poultry RP = domestic retail price for poultry RS = domestic retail supply for poultry PD = domestic producer demand for live birds RMC = retail marginal cost FS = domestic farm supply FMC = farm marginal cost QV= quota value by price Θ = conjectural elasticity of industry output η = absolute value of the demand price elasticity (PT, B, PK donate the poultry, beef, pork respectively) **Exogenous Variables** FP = domestic farm price I = income level for domestic market EX = total domestic exports IM = total domestic imports Conv = the conversion factor of the W_i = other input price, labour, electricity, etc.

3.1.6 Modeling the U.S. and EU Poultry Industries

The U.S. and EU are the main poultry exporters in the world. To analyze Canadian international trade, it is necessary to specify a general model of the U.S. and EU poultry markets. Previous studies have shown that there is oligopoly power in the U.S. meat industry. This assumption is imposed in the current model. Again, the method of *Appelbaum (1982)* is adopted to estimate the U.S. poultry industry model. This study only allows for the estimation of oligopoly power. However, oligopsony power might also exist in the U.S. poultry industries. In the current study, it is assumed that poultry trade is happening at the retail sector, and therefore only oligopoly market power of the U.S. poultry industry is estimated.

Figure 3.4 U.S. and EU Poultry Industry under Market Power



The U.S. poultry model incorporates the assumption of oligopoly power at the retail and processor sectors. Therefore, processors would like to sell where marginal revenue (MR) equals retail supply or marginal cost (RS). The structure of the model is different from the Canadian one, because there is no supply management in the U.S. Farm supply is a function of farm price rather than the farm marginal cost. The EU market structure is assumed to be the same as the U.S. one. Figure 3.4 shows that the U.S. and EU's retail price is higher than its export price without the export subsidies. Table 3.5 summarizes the model.

Table 3.5 Table of Modeling U.S. and EU Poultry Industry

Consumer Demand $RD_{PT} = f(RP_{PT}, RP_B, RP_{PK}, I)$ Processor Demand $PD_{PT} = f(FP, RMC, W_i)$ Farm Supply $FS_{PT} = f(FP, W_i)$ Oligopoly Power $RP_{PT} = RP_{PT}^{CA} = RMC_{PT}^{CA} \cdot (1 - \theta/\eta)$ Quota Value $QV = FP_{PT} - FMC_{PT}$ Market Equilibrium linkage $FS_{PT} = PD_{PT}$ $RS_{PT} = (RD_{PT} + EX - IM)/conv$ Market Power Equation $RP_{PT} = RMC_{PT} * (1 - \theta/\eta)$ $\eta = -(\partial RD / \partial RP)(RP / RD), \eta > 0$	**Endogenous Variables** RD = domestic retail demand for poultry RP = domestic retail price for poultry RS = domestic retail supply for poultry PD = domestic producer demand for poultry RMR = retail marginal revenue FP = domestic farm price FS = domestic farm supply W_i = input prices θ = conjectural elasticity of industry output η = absolute value of the retail demand price elasticity PT, B, PK donate the poultry, beef and pork **Exogenous Variables** I = income level for domestic Market EX = total domestic exports IM = total domestic imports W_i = other input prices, feed, labour, electricity

3.1.7 Consumer Surplus, Processor Profits, Producer Surplus Identities

In Chapter 2, the methodology of calculating consumer and producer surplus, and processor profits were introduced. All of these variables are specified as equations and

introduced into the trade model as identities. The specifications of these equations are as follows:

Canadian Consumer Surplus:

CACW = 0.5*(CADMINT-CARPCK)*CACON

where CACW represents the consumer surplus of the Canadian chicken and turkey models, CARPCK represents the Canadian chicken (turkey) retail price, CACON is total Canadian domestic consumption, and CADMINT is the intersection of the retail demand function with the vertical axis.

The U.S., EU Consumer Surplus:

CW = 0.5*(DMINT-RPCK)*RDCK

where CW represents the consumer surplus of the U.S. and EU models, DMINT is the intersection of the retail demand function with the vertical axis, RP represents retail price, and RDCK represents the total consumption.

Canadian Processor Profits:

CAPS = (CARPCK- CARMC)*CACON + (CAEXP-CARMC)*CAEX

The processor profits of Canadian poultry processors (CAPS) are made up of two parts: the domestic market and the international market. The profit they gain from the domestic market is higher than from the international market. The profits generated from the domestic market are calculated as the Canadian chicken (turkey) retail price (CARPCK) less marginal cost, multiplied by Canadian domestic consumption (CACON); while profits from the international market are calculated as the difference between export prices (CAEXP) and marginal costs (CARMC), multiplied by the exports (CAEX).

The U.S. and EU Processor Profits:

PS = (RP-RMR)*RSCK

Since the export subsidy is from both the U.S. and EU governments, in the current study it is assumed that the U.S. and EU poultry processors get the same profits in the international market as in the domestic market. Processor profits are calculated as the difference between the retail price (RP) and the retail marginal price (RMR), multiplied by the total supply (RSCK).

Canadian Producer Surplus:

CAPW= 0.5*(CAFMC-INT2)*CAPDCK

where CAPW represents the producer surplus of the Canadian chicken and turkey models, CAFMC is the chicken (turkey) marginal cost, CAPDCK is the total farm supply, and INT2 is the intersection of the farm supply function with the vertical axis.

The U.S. and EU Producer Surplus:

PW = (USFPCK-USIT)*USPDCK*0.5

where PW presents the producer surplus in the U.S. and EU, USFPCK is the farm price, USPDCK is total supply, and USIT is the intersection of the farm supply equation with the vertical axis.

3.2 Data Requirements

As introduced in Chapter 2, there is a possibility of market power in the U.S., Canadian and EU chicken (turkey) industries as well as in other countries where the data to test for such phenomena is unavailable. In order to test for market power, two market levels need to be constructed for each of these countries, while to estimate the degree of

market power in poultry industries, simultaneous equation systems must be estimated. These systems include the equations for chicken (turkey) retail demand, processor demand, and farm supply and market power.

In the previous section, the demand functions for each country were specified. Following consumer theory, the market demand function for a commodity is obtained by summing the demand functions of individual consumers. The per capita retail demand for poultry is a function of the retail price of poultry, the prices of all other substitute commodities, and income. The prices of all goods and income are taken into account by including the Canadian CPI as a deflator for imposing homogeneity of degree zero in prices and income as a maintained hypothesis.

The theory of the firm indicates that firms maximize profits given input and output prices, or minimize costs subject to a given output with fixed input prices. The processor demand equation contains the variables of farm and other input prices (as discussed in the previous chapter) to account for a possible structural change. The aggregate supply function states the quantity that is supplied by all producers is a function of output prices. Based on these discussions, the farm supply equations are modeled as a function of farm prices (farm marginal cost for the Canadian model), farm input prices (feed cost), and lagged dependent variables in the current study.

Market power expressions are imposed in the system for the U.S., Canadian and EU models. This expression is modified by the inclusion of a variety of variables: net trade, the number of firms, a time trend, and other input prices.

In general, the U.S. chicken and turkey, and the EU chicken model contains the above four equations and two identities for closing the model. For estimating the model,

per capita consumption, retail price of poultry, production at the processor level, farm price, farm supply and net trade are required to be endogenous. The data of the related exogenous variables such as retail prices of beef and pork, income, input prices (feed cost, labour, and utility) and number of firms are also important.

The Canadian model is similar to the U.S. one with one difference: The Canadian poultry market is modeled under supply management. In addition to the variables in the U.S. model, quota values are important.

Aside from the above countries, there are some other major poultry exporters and importers in the world market such as Brazil, Mexico, China, Russia, and Japan. For these countries, only the export supply and import demand functions will be estimated. Therefore, data on import and export quantities, import and export prices, production, trade policies, and exchange rates are required.

3.3 Sources of Data

The *Production, Supply, and Distribution (PS&D) online database* maintained by *U.S. Department of Agriculture* provides information on quantities for chicken and turkey for all the countries. These variables include production, total imports, total supply, total exports, and total domestic consumption. The *International Macroeconomic Data Set* published by the *USDA*, provides macroeconomic data such as CPI, income, population, exchange rates, and income for all the countries.

Canadian retail and farm prices of chicken and turkey are obtained from the *Poultry Market Review,* which is published by *Agriculture and Agri-Food Canada*. U.S. retail and farm prices are from the *Poultry Yearbook*, published by the *USDA*. The

Agriculture Statistical Year Book published by European Commission provides producer price data for chicken. Data for EU chicken, pork, and beef retail prices are obtained from the *European Marketing Data and Statistics*. The import and export prices of Brazil, Russia, Mexico, China, Japan and EU (turkey) are calculated using data from the *FAO Statistical Database*. This is accomplished by dividing the values by quantities. All prices are converted into U.S cents per kilogram using appropriate exchange rates.

Statistics Canada industry publications *(31-203 Canadian Manufacturing Industry Statistics)* provide the number of firms in the Canadian poultry industry, person hours paid and input cost values. The farm quota price data is from the Chicken Farmers of Canada and the Canadian Turkey Marketing Agency. The feed cost is from the *Statistics Canada database CANSIM*, while the *Longitudinal Research Database* provides the firm concentration ratios in chicken and turkey processing industries.

3.4 Data Description

3.4.1 Production

Figures 3.5 and 3.6 present chicken and turkey production in main importing and exporting countries. Twenty-five years of data are reported in these figures for poultry importers with different scales. These data indicate that chicken production in the major chicken importing countries has been increasing for the past 25 years. The growth rates in these countries are different, but the increasing trend is the same.

The production of U.S. chicken has been increasing over the last 25 years. After almost seven percent growth in production in 1999, broiler production growth slowed to less than 3.5 percent in 2001. This value is below the average growth rate of five percent

during the past 20 years. U.S. turkey production increased 3% in the past 30 years. The U.S. broiler and turkey industries were hard hit by the Russian economic crisis in the 1990's.

The average increasing rate of broiler production over the past 25 years in Brazil is 10%. Poultry analysts generally agree that double-digit poultry production growth in Brazil is over. However, production in the coming years will continue to grow as a result of previous investment in the Brazilian poultry sector *(USDA, Brazil: Issues and Analysis, Briefing Room, 2000)*. Nearly 98 percent of the poultry meat produced in Brazil is broiler meat, with the balance coming mainly from turkey production, which is increasing rapidly but from a small base *(USDA, Foreign Agricultural Service Gain Report - Poultry and Products, 2001)*. Some Brazilian processors have adopted a strategy of adding value to their products in order to get more profit from trade. In 2001, about 55 percent of the estimated broiler meat production in 2001 consisted of broiler parts, and only 45 percent whole broilers. It is predicted that value-added broiler production will continue to increase at a much higher rate than whole broiler production for export purposes.

Chicken production in China has increased during the past ten years, as well; the increase is as high as 12%. This increase is mainly due to the industry becoming more commercial. Chicken production in China during 1996-1997 fell significantly, the main reason being that chicken production had developed too fast in the past few years (an annual average increase rate of 25%). Chicken production has been growing far more than market demand. In 1996 and 1997 chicken producers lost production opportunities because they found it difficult to maintain business *(USDA, Foreign Agricultural Service*

Gain Report - Poultry and Products, 2001). In contrast to most western countries, Chinese consumers prefer dark meat.

Unlike other countries, Japanese chicken production has decreased during the past 25 years, due to lower import prices of poultry products. Japanese consumers have shifted demand from poultry to red meat and fish in recent years, forcing farmers to reduce output. Processors vulnerable to low import prices, such as small and medium scale operators, are declining. This may be another reason for the production decrease. Japan's poultry production is expected to keep decreasing in following years *(USDA, Foreign Agricultural Service Gain Report - Poultry and Products, 2001).*

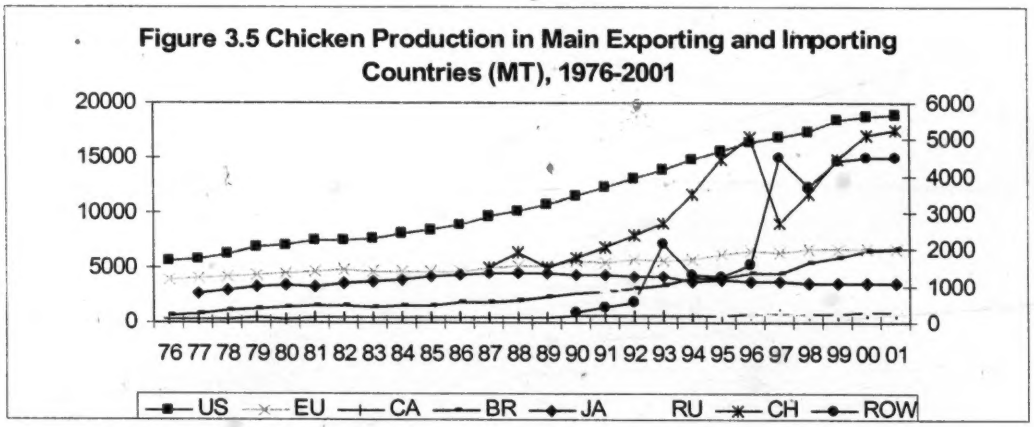
Russia's chicken and turkey production has fallen during the past ten years. This result may be explained as follows: the high price of feed, the lack of available trained professionals, and poor breeding practices and genetics, which continue to undermine industry profitability *(USDA, Foreign Agricultural Service Gain Report - Poultry and Products, 2001).* According to statistical information, in 1999 and 2000, 150 poultry farms went bankrupt, as the industry lost an estimated $0.8 billion. This is potential evidence that Russian poultry production may continue to decrease in the following years.

Turkey meat production in Mexico has been slowly increasing for the last 10 years at a rate of 2 percent. Mexico's domestic meat production only accounts for less than 10 percent of total consumption. Mexican producers find it difficult to compete against turkey imports due to poor economies of scale and limited integration.

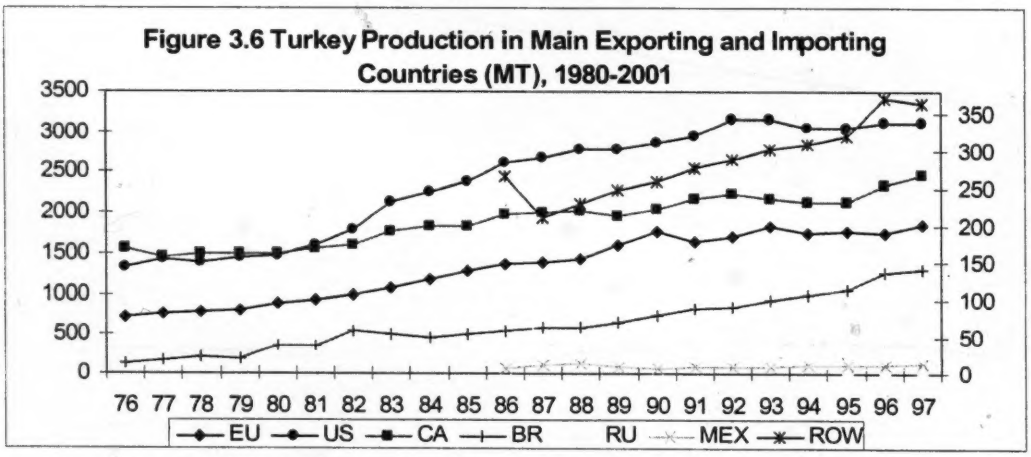
The rest of the world's total broiler and turkey production shows some signs of increase. During the period of 1990-2000 the average increase was as high as 54%,

especially during the period 1996-1997. The increase of poultry production in the rest of the world may be caused by lower feed prices for poultry, and strong poultry meat demand.

The above information indicates that chicken and turkey production has shown an increasing trend during the past 25 years in the main poultry-exporting countries. This trend may continue in the following years. Conversely, the production levels of the importers show some decrease, except in countries such as China and Mexico.



(Source: USDA, Production, Supply, and Distribution Database, 2003)



(Source: USDA, Production, Supply, and Distribution Database, 2003)

3.4.2 Imports

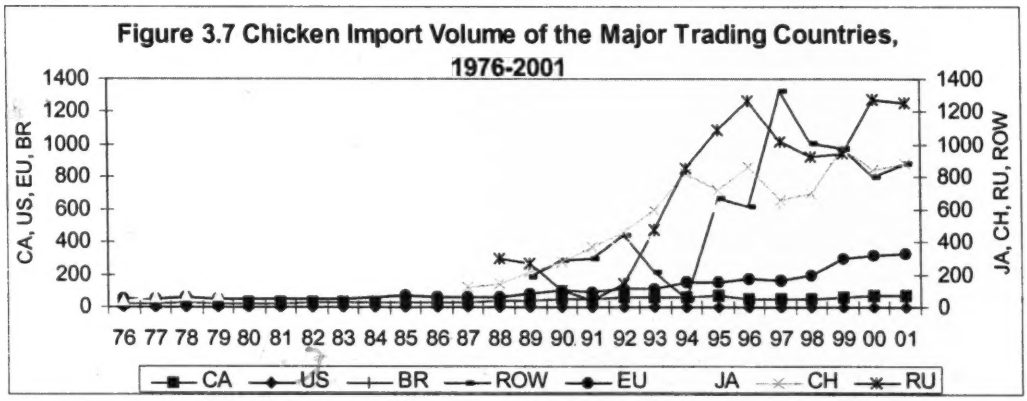
Figures 3.7 and 3.8 show that world chicken and turkey imports have increased dramatically since 1990. However, most of the chicken and turkey net exporters import very little chicken, even during this period. U.S. chicken imports historically remain at a rate of almost zero with the exception of limited imports during 1996-2001. U.S. turkey import volumes remain at zero for the entire period. This is perhaps due to the high standards for food safety applied to imported food products by the U.S. government. For example, in the U.S., a bill banning low-level feeding of seven antimicrobials (bacitracin, erythromycin, lincomycin, penicillin, tetracycline, tylosin, and virginiamycin) was introduced in the House of Representatives in November 1999 *(USDA, Government Food Safety Policies, 2003)*. Similar policies may be trade barriers for other export countries. Historically, Brazil's chicken and turkey imports have remained zero. However, in duck trading some information shows Brazil is the most important export market for Canada. Unlike the U.S. and Brazil, the EU broiler and turkey imports have increased during the last 25 years. This may be due to the constantly decreasing prices of some exporters such as Brazil. However, TRQs and a safeguard mechanism protect the EU poultry market from excessive poultry meat imports. Imports only account for 3% of domestic consumption.

Unlike the above countries, Russia, Japan and China are net chicken importing countries. Russia's chicken and turkey import data indicate significant increases, except for the Russian financial crisis period between 1995 and 1998. The competitive export prices from some large poultry producing countries, such as the U.S. and Brazil, increase their market share in Russia. The importer anticipation of border crossing restrictions and

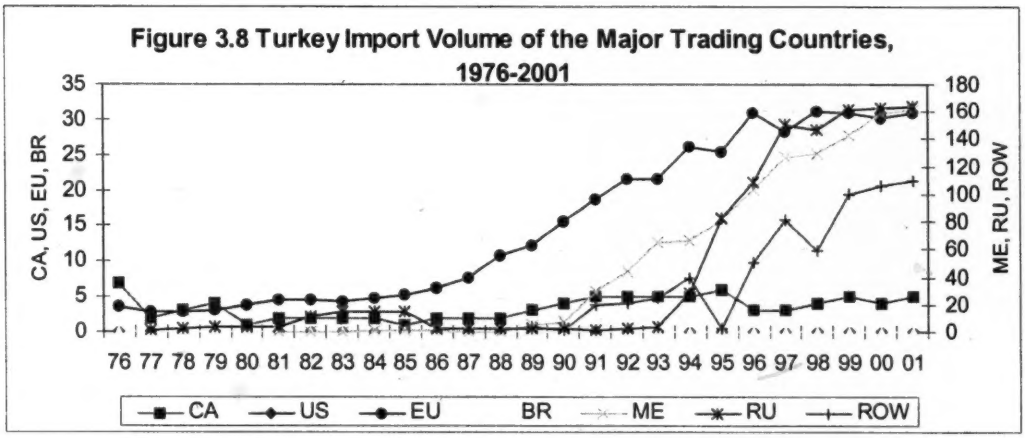
stricter tariff controls based on new legislation led to panic sales and purchases of poultry. Almost 50% of the Japanese poultry products consumed are from foreign sources. No doubt, Japan looks like a lucrative market for foreign companies to enter. The major suppliers are China, the U.S., and Thailand. Japan is one of the main poultry export markets for Canada. Export products include fowl portions raw, whole eviscerated raw turkey, whole eviscerated other poultry, and whole eviscerated raw chicken. Japan ranked as the 12th most important export market for Canada in terms of quantity in 2000.

Mexico has had high turkey import quantities since the 1990's, increasing at an average rate of 50%. Strong demand continually results in an increase of turkey products. Most turkey products imported into Mexico are used for sausage and cold cut production, mainly "turkey ham". Under NAFTA, duty-free access to the Mexican poultry market is scheduled to grow at a compound annual rate of 3 percent until the year 2003 when all imports will be duty free and the quota will be eliminated *(USDA, Foreign Agricultural Service Gain Report - Poultry and Products, 1997)*. Therefore, turkey product imports are predicted to continue increasing.

Based on the data, the rest of the world's chicken and turkey imports experienced a rapid pace of growth in the 1990's. The average increase rate for broilers is 110% and for turkey is 280%. The huge increase in both chicken and turkey reflects the potential increase in poultry demand in other countries, such as many Asian countries with the exception of Japan and China, and the Middle Eastern countries.



(Source: USDA, Production, Supply, and Distribution Database, 2003)

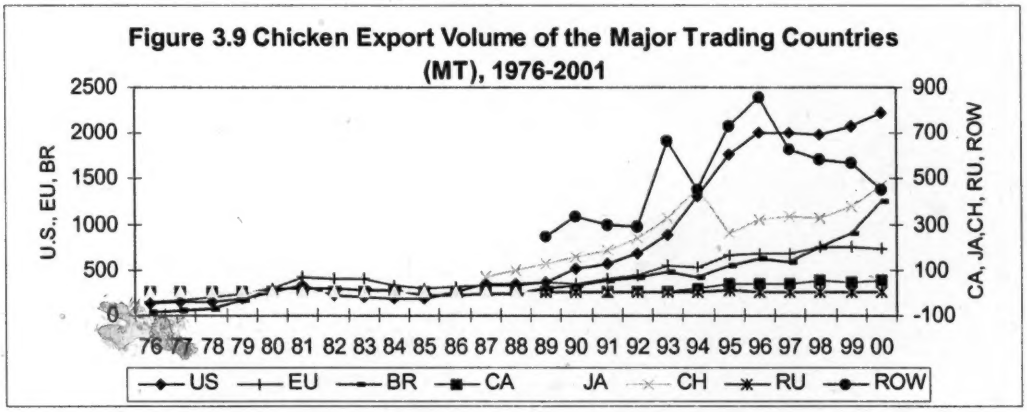


(Source: USDA, Production, Supply, and Distribution Database, 2003)

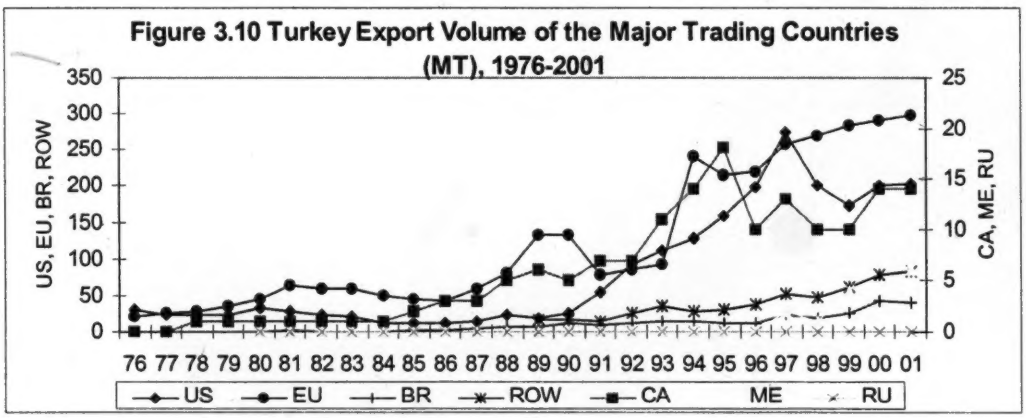
3.4.3 Exports

The U.S. is the biggest net chicken exporter in the world poultry market. Figure 3.9 clearly indicates that the volume of U.S. chicken exports has been increasing during the past 25 years, especially after the 1990's. The average growth rate during the past decade is 14%. The increase in U.S. chicken exports has slowed from 1996-1999 due to the Russian economic crisis. However, after 1999 U.S. poultry exports reached another record level, because chicken products were moving into Mexico, Japan, the Caribbean, and South American markets, compensating for declining Russian demand. Prior to 1991

the U.S. turkey export volume was not significant. After 1992, the U.S. increased its turkey exports with a large range. The average growth rate between 1992 and 1997 was 25%, as seen in Figure 3.10. After 1997, as with the U.S. chicken export market, turkey exports began decreasing due to the drop-off in sales to Russia and China. However, after 2000 U.S. turkey exports returned to an increasing trend.



(Source: USDA, Production, Supply and Distribution Database, 2003)



(Source: USDA, Production, Supply, and Distribution Database, 2003)

The total volume of Brazil's broiler exports in 2001 reached 1,241 metric tons, up 40% from 2000. Turkey export volumes reached 42 metric tons. The average broiler export growth rate was 15%, and turkey was 32%. This information shows that Brazil has been enhancing its poultry exports in recent years. As with other export countries, like Canada and China, Brazil complained about the export subsidies that the U.S. and the EU provide to poultry products (in 2001, the WTO ruled that the United States' Food Sales Corporation (FSC) confers a benefit to exporters and therefore constitutes an export subsidy). More recently, Brazilian poultry exporters have been facing problems with the New Argentine regulations for residue control and hygiene in foods, which has led to the detention of several shipments of poultry and pork exports from Brazil (*Agricultural and Agri-food Canada, 2001)*. The importing markets for Brazil's poultry are Russia and Asian countries.

China's poultry exports have been increasing during the past 13 years. The main export markets for China's chicken exports are Japan, Korea, and Russia, the reason being the relatively low labour and material costs in China that makes the export price more competitive. Transportation costs are relatively low because the physical distance is shorter.

The poultry export data show that a few poultry exporters control the majority of poultry exports, like the U.S., EU, and Brazil. With the exception of China, the main poultry importing countries' exports are rare.

3.4.4 Consumption

U.S. domestic consumption of poultry meat has been increasing during the last 25 years with an average growth rate of 5%. Regarding chicken and turkey, the demand for

chicken is growing faster than turkey. Health and nutrition awareness of consumers may have changed their preferences from red meat to poultry products in the 1980's. Another reason for increasing demand may be population growth, combined with a growing demand for convenience food. Chicken meat consumption is predicted to increase at a level of 3-4% level over the next decade. Like other Western countries, demand for turkey meat is more significant during holidays in the U.S.; in 2001, 30% of all turkey consumed was during Thanksgiving and Christmas. Turkey consumption is expected to keep increasing, as well due to consumer recognition of turkey's good taste and nutritional value.

Both domestic broiler and turkey meat consumption in Brazil has been increasing over the past 25 years. Brazilian total chicken consumption is much higher than turkey. In 1994, Brazil initiated an economic stabilization program known as the Real Plan, which was highly successful in reducing long-standing inflation. The plan also inaugurated one of the world's largest privatizations *(USDA, Brazil: Issues and Analysis, ERS, 2000)*. Since the economic stabilization program was initiated, there has been a significant increase in Brazilian chicken consumption. From 1994 to 2001, the average increase in consumption was five percent. Brazilian chicken consumers still have an overwhelming preference for large whole broilers. Large Brazilian poultry processors are shifting their sales mix strategies toward broiler parts (mostly leg quarters and breast meat). Like other Western countries, Brazilian turkey consumption remains highly seasonal. About 85 percent of whole turkey sales occur during the Christmas period, while processed turkey products, such as sliced loaf, nuggets, etc. are consumed throughout the year (*Agricultural and Agri-food Canada, 1999).*

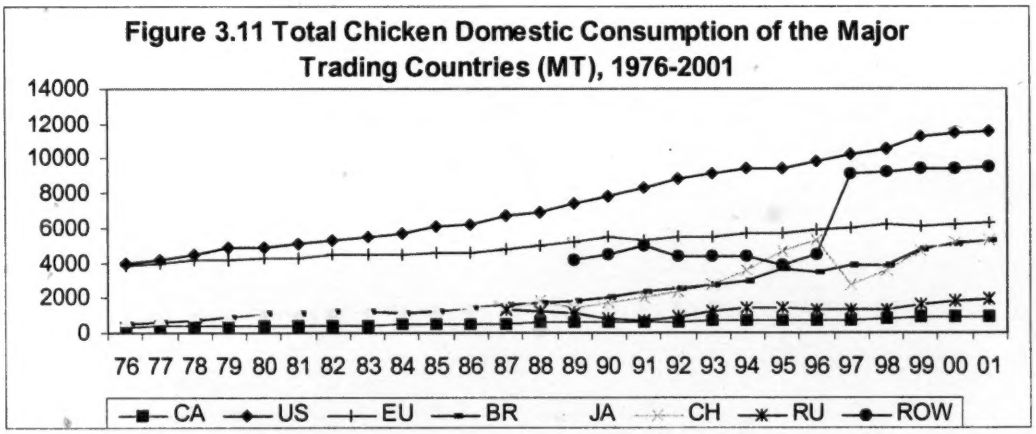
Even though chicken production in Japan is not high, Japanese consumers consume 1.75 million tons of chicken per year, of which one third is imported. An increasing proportion of chicken consumption is occurring in the hotel and restaurant sectors as opposed to home-use consumption. Japanese consumers prefer dark meat to light meat, finding breast meat to be dry and tasteless. This preference is different from most Western countries. Japanese consumers are concerned with poultry appearance when making these purchases. Consumers prefer chicken or turkey skin to be white instead of yellow. Canadian producers may have an advantage since poultry products from Canada always have white skin.

China's chicken meat consumption has increased quickly and is expected to continue growing over the next several years. Chicken consumption increases faster in urban areas than in rural areas due to greater availability of chicken products and changing health concerns of urban consumers. Currently, Chinese consumers are beginning to accept turkey products. Turkey consumption is predicted to increase over the following years. However, as compared with chicken, China's turkey consumption is very low.

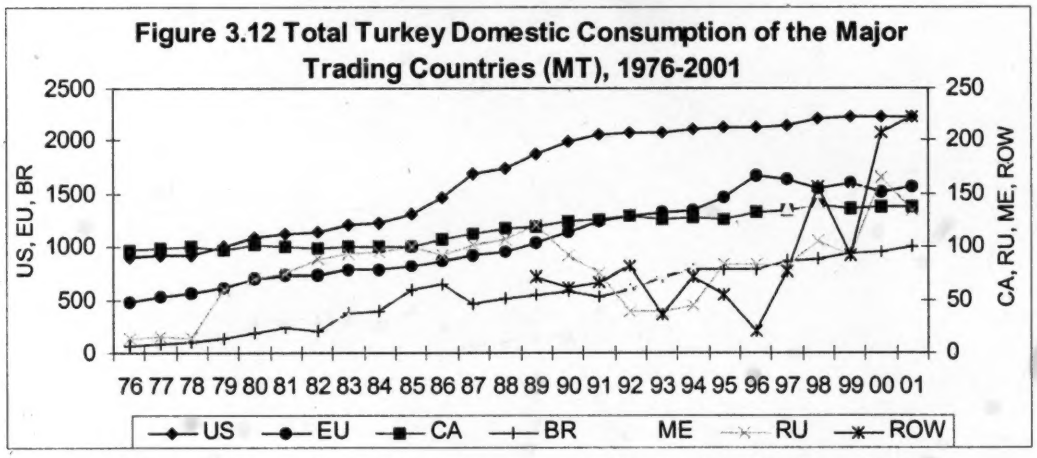
Turkey consumption in Mexico is growing rapidly due to improved consumer purchasing power and the availability of turkey products at affordable prices. Similar to Brazil, most turkey meat consumed in Mexico is in the form of cold meat *(USDA, Livestock and Poultry: World Market and Trade Circular Archives, FAS, 2001)*. Most of the whole turkey demand is during the Christmas season.

Figures 3.11 and 3.12 suggest that Russia's chicken and turkey consumption have continued to increase, except during the Russian economic crisis period between 1996

and 1998. Russian consumers strongly favor poultry meat over more expensive pork and beef products *(USDA, Livestock and Poultry: World Market and Trade Circular Archives, FAS, 2001)*. Russian poultry consumption is expected to increase as both domestic production and imports grow.



(Source: USDA, Production, Supply, and Distribution Database, 2003)



(Source: USDA, Production, Supply, and Distribution Database, 2003)

3.4.5 Prices

Figure 3.13 shows the nominal chicken retail price (in U.S. cents) in Canada, the U.S. and the EU. All prices had decreasing trends during 1976-2001. Among them,

Canada's chicken retail price was higher than the retail prices for the U.S. and EU due to the existence of supply management. The retail prices in Canada have declined over the past ten years. This may be due to the expansion of chicken production. Similar to chicken, Canada's turkey retail price is higher than the U.S. (Figure 3.14).

Figures 3.15, 3.16, 3.17 and 3.18 display the import and export prices of poultry products in major trading countries. Japan's chicken import price is higher than for China and Russia, as seen in Figure 3.15. Figures 3.16 and 3.18 show that Brazil's chicken and turkey export prices are not as stable as the EU turkey export price, especially over the past 10 years. Finally, Figures 3.17 and 3.18 show that Mexico and Russia's turkey import price levels are lower than the EU and Brazil's turkey export price levels.

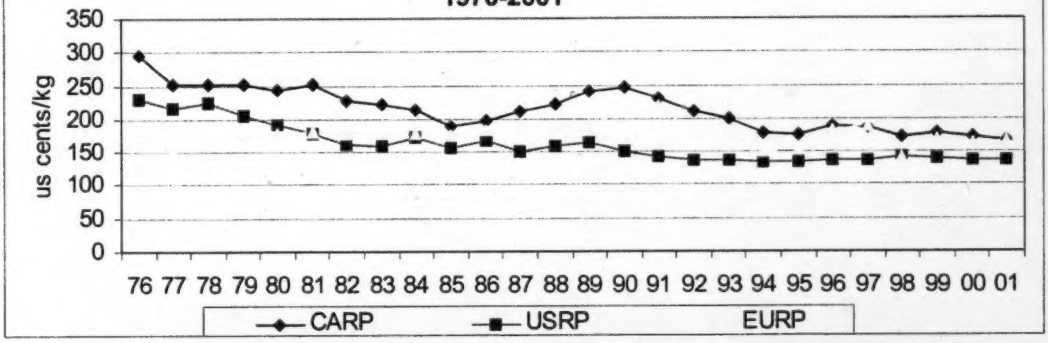
The Canadian, U.S. and EU chicken and turkey farm nominal prices have been decreasing during the past 25 years (Figure 3.19 and 3.20). The Canadian turkey farm price level is higher than the U.S. market. Furthermore, the Canadian chicken and turkey quota values are shown to be increasing in Figure 3.21.

Based on previous studies, the market power equations in the current study are modeled as a function of net trade, the number of firms (or firm concentration ratio), farm marginal cost, and farm quota values (only for Canada). In Figure 3.22, one can see that the Canadian, U.S. and EU nominal farm price decreases are obvious. However, the nominal quota prices remained relatively constant prior to 1995 and continued to increase after 1995. From 1976 to 2000, Canada was a net chicken importing country; however, the net chicken imports dropped after 1994 due to Canadian poultry export policies. Before 1986, Canada was a net turkey importer rather than an exporter. After 1986,

Canada exported more turkey than it imported, and the exports dramatically increased after 1994.

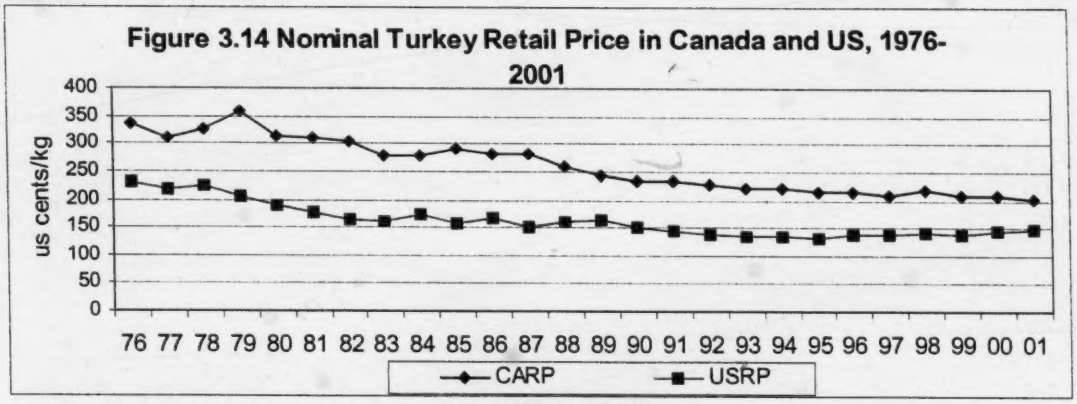
Figure 3.22 shows the number of the firms in the Canadian poultry processing industry. The decreasing rate in the number of firms indicates the possibility that market power does exist. For the U.S. poultry industry, the firm concentration ratio is used instead of the number of firms. The high concentration rates indicate that a few processors provide the majority of the poultry production. The increase in this value in the U.S. during the past 25 years suggests that fewer processors are producing a majority of the poultry products, therefore providing further evidence that market power may exist in the U.S., Canadian and EU chicken markets.

Figure 3.13 Nominal Chicken Retail Price in Canada, U.S. and EU, 1976-2001



(Source: USDA, Poultry Year Book, 2002; Agriculture and Agri-Food Canada, Poultry Market Review, 1976-2002; Eurostat, European Marketing Data and Statistics 1976-2002)

note: CARP = Canadian retail price, USRP = U.S. retail price, EURP = European Union retail price, BRRP = Brazil retail price, CHRP = China retail price, JARP = Japan retail price, BREXP = Brazil export price, CAEXP = Canadian export price, TRUIMP = Russian turkey import price, TMAIMP = Mexican turkey import price, CAFMC = Canadian farm marginal cost, USFP = U.S. farm price, EUFP = EU farm price, CAQV= Canadian chicken quota value, CATURQV=Canadian turkey quota value, EU= European Union, U.S.= The United States, CA= Canada, BR=Brazil, RU=Russia, MX=Mexico, ROW= rest of world.



(Source: USDA, Poultry Year Book, 2002; Agriculture and Agri-Food Canada, Poultry Market Review, 1976-2002)

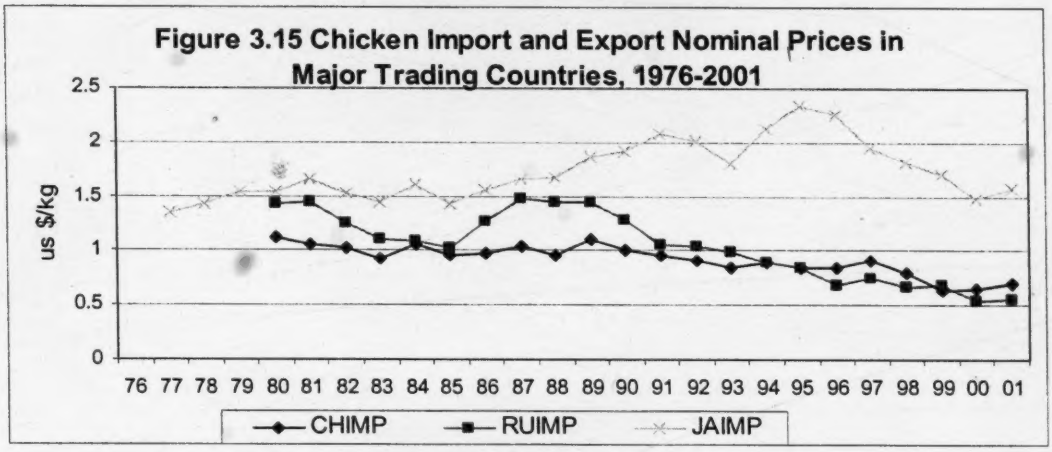
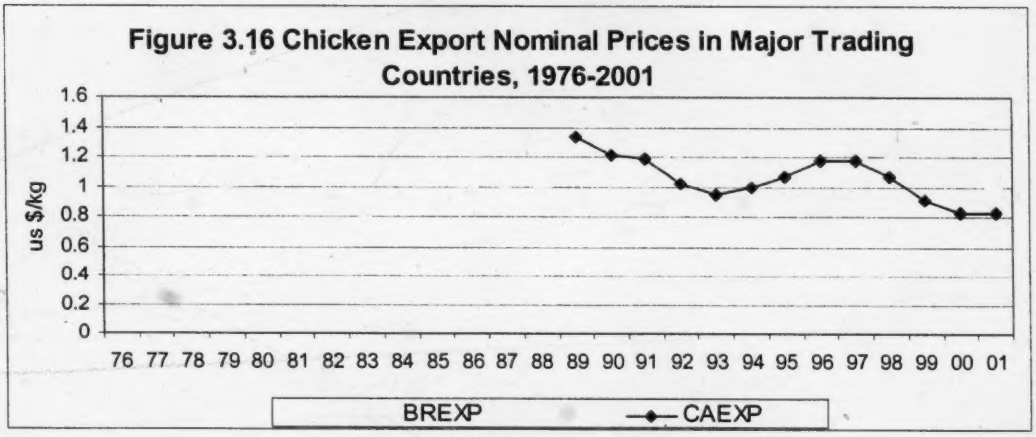
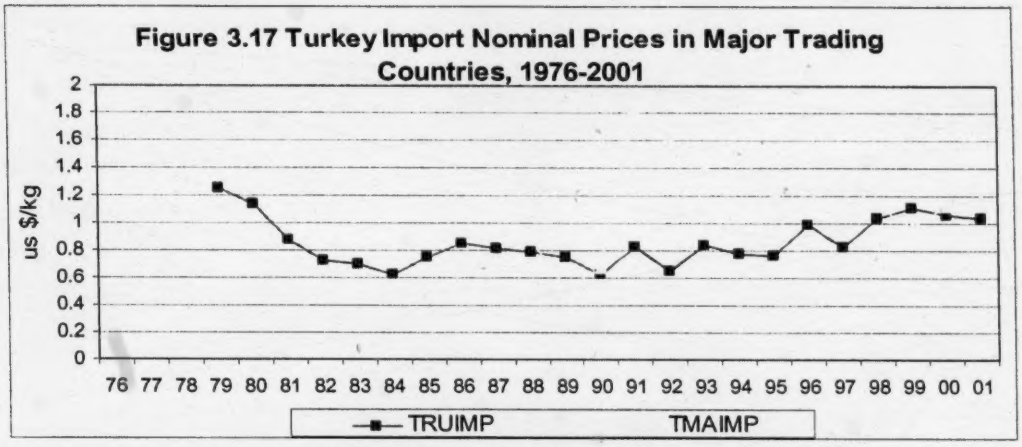


Figure 3.15 Chicken Import and Export Nominal Prices in Major Trading Countries, 1976-2001
us $/kg
2.5
2
1.5
1
0.5
0
76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01
CHIMP
RUIMP
JAIMP

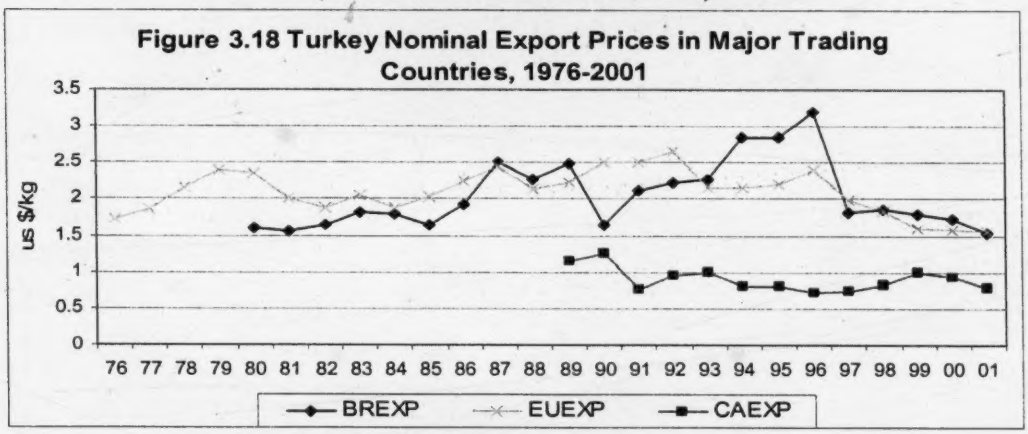
(FAO Statistical Data Base, 2002)



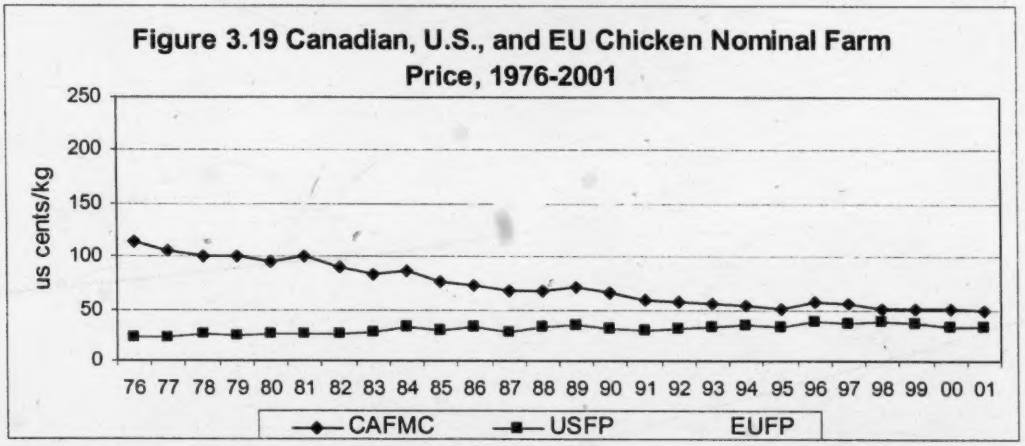
(FAO Statistical Data Base, 2002)



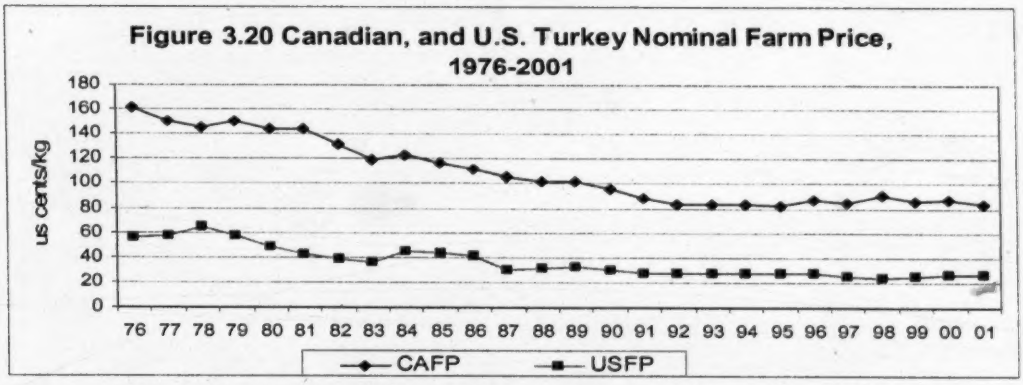
(FAO Statistical Data Base, 2002)



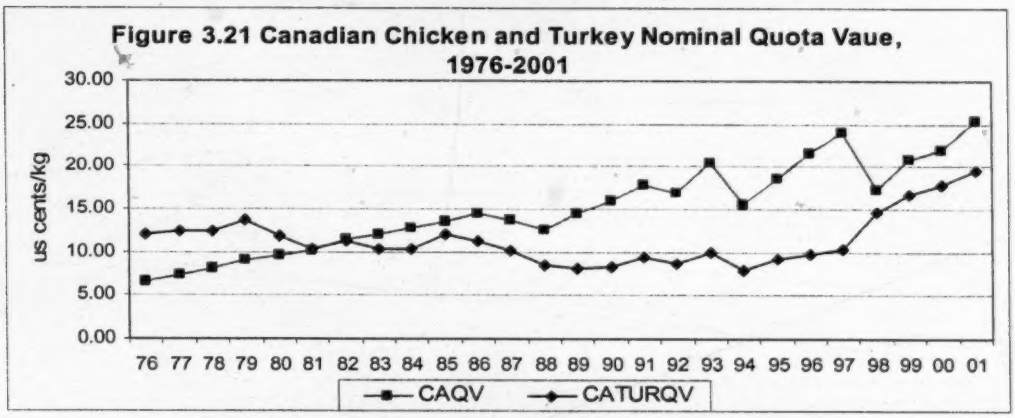
(FAO Statistical Data Base, 2002)



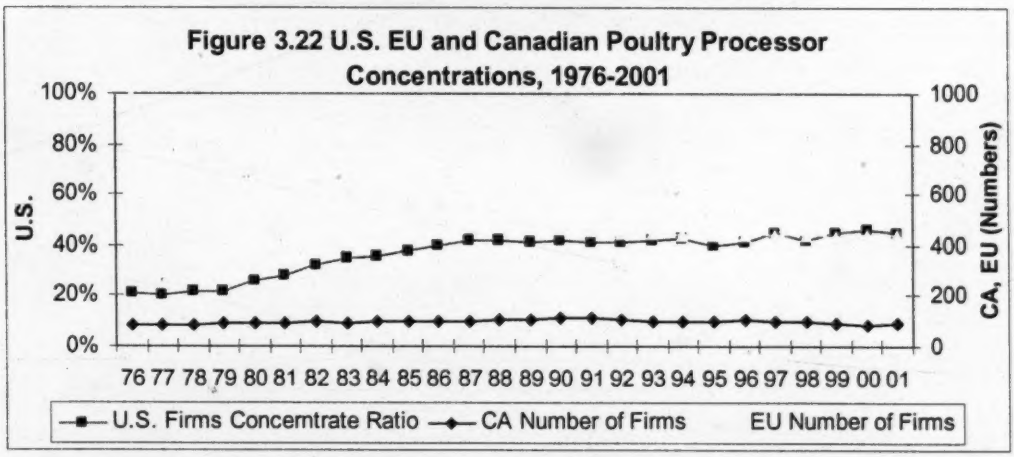
(Source: USDA, Poultry Year Book, 2002; Agriculture and Agri-Food Canada, Poultry Market Review, 1976-2002; Agriculture Statistical Year Book, European Commission, 1976-2002)



(Source: USDA, Poultry Year Book, 2002; Agriculture and Agri-Food Canada, Poultry Market Review, 1976-2002)



(Source: Chicken Farmers Canada; Canadian Turkey Agency)



(Source: Statistics Canada, Canadian Manufacturing Industry Statistics, 1976-2002; U.S. Census Bureau, Longitudinal Research Database, 1976-2001; Agriculture Statistical Year Book, European Commission, 1976-2002)

3.5 Estimation

The program Time Series Processor (TSP) is used to estimate each equation. The U.S., EU and Canadian model systems are estimated simultaneously to ensure that the results in each equation correspond to each other. The retail demand and farm supply equations are based on linear functional forms. The processor demand functions are not linear after imposing the market power relationships. The parameters for all variables need to be estimated together. For other countries, import demand and export supply single equations are estimated for each country.

With the data and equation specification, a good statistical estimation technique must be chosen. The appropriate technique may keep the results reasonable and consistent. There are many statistical techniques, including ordinary least squares (OLS), generalized least squares (GLS), two-stage least squares (2SLS), and three-stage least squares (3SLS).

3.5.1 Single Equation Estimation

There are several statistical estimators that can be used to estimate single equations, including OLS, 2SLS, and limited information maximum likelihood (LIML). The objective of OLS estimation is to minimize the sum of squared residuals and it is a best linear unbiased estimator. 2SLS is a method of extending regressions to cover models, which violate the OLS regression's assumption of recursiveness, specifically models where the researcher assumes that the disturbance term of the dependent variable is correlated with the independent variables. LIML is an alternative estimator to 2SLS. It computes maximum likelihood estimates for a linear model with endogenous variables on

the right-hand side (and normally distributed disturbances). The advantages of LIML over 2SLS are asymptotic efficiency and a small sample distribution with less bias. The disadvantage of LIML is that the estimates are more sensitive to specification error in the lists of included and excluded variables (*Hall and Cummins, 1999*). Obviously, OLS is the best estimator for single linear equation estimation. Therefore, in this study, OLS is used to estimate the single demand and supply equations.

3.5.2 Estimation of Nonlinear System of Equations

With TSP, equation systems can be estimated by simultaneous methods, including nonlinear least squares (LSQ) and full information maximum likelihood (FIML). LSQ is a minimum distance estimator that can be used to compute nonlinear single equation least squares, nonlinear two-stage least squares, nonlinear multivariate regression, and SUR (seemingly unrelated regressions). If a model has more than one regression equation, the disturbances of the equations are correlated. If two or more equations share the same parameters, they must be estimated simultaneously. The LSQ command is a generalized least squares method: the disturbance of the model is assumed to be independent across observations, but to have free covariance across equations. This estimator converges to the maximum likelihood estimator when the disturbances are multivariate normal.

Therefore, in the current study, each equation or simultaneous system is estimated using TSP version 4.5. The single equations of other countries are estimated using OLS. The U.S., EU and Canadian simultaneous model systems are estimated separately by multivariate regression estimation with maximum likelihood methods. First, the retail demand and farm supply equations are estimated separately using maximum likelihood

methods. At this stage 0.01 is used as the starting value for all the parameters. This value is chosen close to zero so that parameters not yet in the model will have little or no effect on the estimation. After that, the simultaneous equation systems are re-estimated simultaneously. For this stage, the final values from the independent estimation are used as starting values under the assumption that the two values would be similar.

3.5.3 Statistical Tests

All the variables and equations in this model are tested to see if they are statistically significant. The terms used to test the estimation results are usually the t-statistic, R^2 statistic, Durbin-Watson (DW) statistic and the likelihood ratio test. A t-test is commonly used to test a hypothesis of a single coefficient in the model being statistically significant from the pre-specified value (zero). The t-statistic value can be compared with the critical value, to see if the variable is significant. The DW value measures the correlation between each residual and the residual for the time period immediately preceding the one of interest. If the DW values show highly correlated relationships between variables, autocorrelation factors need to be imposed in the model. The Likelihood Ratio (LR) test evaluates the unconstrained model (after imposing autocorrelation factor) and the constrained model (without autocorrelation factor). Since the demand and supply systems are tested in the current study, restrictions are tested using the LR test. LR test statistics are the negative of the difference between the restricted and the unrestricted models, multiplied by 2, and are compared to the Chi-squared value.

3.5.4 Validation of the Model

A useful model must be validated against real world data. Several statistics can be used to show the adequacy of the model: the correlation coefficient between the actual and simulated values, the Root Mean Squared Error (RMSE), the Percent Root Mean Squared Error (PRMSE), and The Mean Square Error Decomposition.

The correlation coefficient measures how closely the simulated value correlates with the original value. This statistic is always between -1 and 1. If it is -1, the predicted value is highly negatively correlated with the actual values. If it is close to 1, then the predicted value is highly positively correlated with the actual values, and implies a better simulation base for analysis. The RMSE is a generalized standard deviation. It provides a measure of the error of the predicted values from the actual values. Usually the lower the RMSE value the more accurate is the prediction. The PRMSE reports the percentage of error in the simulated value that is due to estimation bias. While similar to RMSE, it provides the relationship between RMSE to the mean of the actual data. Therefore, the PRMSE can be used to indicate the average error over the sample. The MSE decomposition breaks the prediction into three different components, which provide the measure of systematic and non-systematic errors: MSE due to bias, variance, and covariance. The MSE due to bias measures the amount of the MSE that is accounted for by systematic error (it measured the distance between the mean of the projection and that of the actual series). The MSE due to variance measures the accuracy of the prediction of the variances. The MSE due to covariance measures how much of the MSE is due to unsystematic error (the effort remaining after taking into account deviation from average value and average variability) *(Theil, 1966)*.

3.6 Assumptions

Certain assumptions are made in this model. First, it is assumed that poultry is homogeneous products. This means all poultry products in the world markets are the same, and barring intervention costs have the same price. This assumption is imposed because there is difficulty in getting the data to test for less than perfect substitutability between different types of poultry products. The second assumption is that except for Canada, the EU, and the U.S., all other countries' poultry markets are collapsed into one international relationship, not accounting for market structure. This may oversimplify reality, since one knows that market power may also exist in Japan or other countries. Future studies may question these two assumptions.

3.7 Summary

In this chapter, a model structure was developed that accounts for consumer, processor, and farmer actions in the chicken (turkey) industries of Canada and other major competitive countries (regions). The model was developed based on the literature review in Chapter 2. Canada, the U.S., the EU, Brazil, Russia, China, and Japan were found to be the major trading markets for the chicken products. The U.S., EU, Brazil, Canada, Mexico and Russia were focused on for the turkey trade. All chicken (or turkey) products were regarded as homogeneous products.

In the second part, data requirements and descriptions were introduced. Each country's poultry market information was also discussed based on the data. This information was presented to understand international poultry markets.

Finally, model estimation methods were discussed for the current study. For each country, each equation or equation system will be estimated using ordinary least squares. Simultaneous model systems are estimated separately by a multivariate regression estimator with maximum likelihood methods. Finally, the validation of the model and the assumptions of this study were briefly discussed.

CHAPTER 4

ESTIMATION AND VALIDATION OF THE BASE MODEL

In Chapter 3 a conceptual model describing the chicken (turkey) industry was developed. To satisfy the objectives of this dissertation, the empirical estimation results for the equations of the econometric model are presented in this chapter. In addition, the results of each country's model are validated. The estimation includes the simultaneous equation systems for Canada, the U.S., and EU and the single import demand and export supply equations for the other major countries. The market power relationships are also included and tested as part of the Canadian, U.S., and EU models.

This chapter is structured as follows: First, the equations of the simultaneous systems for Canada, the U.S., and EU poultry industries will be specified, such that they allow for measurement of market power. Second, the estimation results will be presented and discussed. Third, the statistical model validation test results will be conducted and evaluated.

4.1 Model Specification

4.1.1 Canadian Chicken and Turkey Model Specification

Beyond normal supply and demand considerations, the Canadian chicken (turkey) model contains the additional complexities of supply management and possible market power. The endogenous variables that should be included in the system have been determined in Chapter 2. In this section, the functional form with variables is presented.

The Canadian chicken (turkey) model contains four equations and two identities. The four industry equations are retail demand, processor demand, farm supply and

market power equations. The functional form and variables were already determined in Chapters 2 and 3. The specifications of the equations and identities are listed below:

Retail Demand Equation:

$$CARDCK = ca11 + ca12 * CARPCK + ca13 * CARPTUR + ca14 * CARPBF + ca15 * CAPRPK + ca16 * CAPDI;$$

Processor Demand Equation:

$$CAPDCK = B1 + (BMM + BM1 * (CAW21 / CAFPCK)^{0.5} + BM2 * (CAW31 / CAFPCK)^{0.5}) * CARSCK;$$

Farm Supply Equation:

$$CAFSCK = ca31 + ca32 * CAFMC + ca33 * CAFIP + ca34 * CAPDCK(-1) + ca35 * CATIME;$$

Market Power Equation:

$$CARPCK = \frac{\begin{array}{l}(BMM * (CAFPCK * CAFPCK)^{0.5} + BM1 * (CAFPCK * CAW21)^{0.5} + BM2 * (CAFPCK * CAW31)^{0.5} \\ + BKK * (CAW21 * CAW21)^{0.5} + BM1 * (CAW21 * CAFPCK)^{0.5} + BK2 * (CAW21 * CAW31)^{0.5} \\ + BLL * (CAW31 * CAW31)^{0.5} + BM2 * (CAW31 * CAFPCK)^{0.5} + BK2 * (CAW31 * CAW21)^{0.5})\end{array}}{(1 - \frac{\theta}{\eta})};$$

where $\theta = b0 + b1 * CANF + b2 * CATRADE + b3 * TIME$, and $\eta = -(\partial RD / \partial RP)(RP / RD)$;

Quota Value Identity	$CAQV = CAFP - CAFMC$
Domestic Market Equilibrium Linkage Identity	$CAPDCK = CAFSCK$
Trade Linkage Identity	$CARSCK = CARDCK + CAEX - CAIM$

The definitions of these variables are listed in Appendices A and B. Previous studies *(Appelbaum, 1982; Lopez, 1984; Cranfield, 1995)* specified the market power equation as a function of input prices, industry concentration, a supply management dummy variable and a time trend. In the current study, the best explanatory variables in the equation will be tested. The market power equations in this study are specified differently based on each country's model. For the Canadian chicken industry, this equation is specified as a function of the number of firms, net trade, and a time trend.

A priori, the coefficients on beef, turkey (chicken), and pork prices in retail demand equations are expected to be positive, thus indicating they are substitute goods for chicken (turkey). The income coefficients are expected to be positive reflecting that chicken (turkey) is a normal good. The farm price elasticity in the processor demand equations should have a negative signs. The theory of the firm suggests that processors always wish to purchase live birds from farmers at lower prices and sell their products at high price levels in the retail market. Therefore, in farm supply equations, farm prices should have a positive relationship with the farm supply quantities.

4.1.2 The U.S. and EU Chicken and Turkey Model Specification

The U.S. and EU chicken and turkey industry models are similar to the Canadian industry except for the supply management concern. The functional form of the equation systems are specified as follows:

Retail Demand Equation:

$$USRDCK = a11 + a12 * USRPCK + a13 * USRPTUR + a14 * USRPBF + a15 * USPRPK + a16 * USPDI;$$

Farm Supply Equation:

$$USFSCK = a31 + a32 * USFPCK + a33 * USFIP + a34 * USFSCK(-1) + a35 * TIME;$$

Processor Demand Equation:

$$USPDCK = USB1 + (USBMM + USBM1 * (USW21 / USFPCK)^{0.5} + USBM2 * (USW31 / USFPCK)^{0.5} * USRSCK;$$

Market Power Equation:

$$USRPCK = \frac{\begin{array}{l}(USBMM * (USFPCK1 * USFPCK)^{0.5} + USBM1 * (USFPCK * USW21)^{0.5} + USBM2 * (USFPCK * USW31)^{0.5} \\ + USBKK * (USW21 * USW21)^{0.5} + USBM1 * (USW21 * USFPCK)^{0.5} + USBK2 * (USW21 * USW31)^{0.5} \\ + USBLL * (USW31 * USW31)^{0.5} + USBM2 * (USW31 * USFPCK)^{0.5} + USBK2 * (USW31 * USW21)^{0.5})\end{array}}{(1 - \frac{\theta}{\eta})};$$

where $\theta = b0 + b1 * USNF + b2 * USTRADE + b3 * TIME$

Domestic Market Equilibrium Linkage Identity $USPDCK = USFSCK$

Trade Linkage Identity $USRSCK = USRDCK + USEX - USIM$

Oligopoly market power is assumed to exist in the U.S. poultry and EU chicken industries. The degree of market power is imposed and tested within the model. As with the Canadian model, θ is used to measure the degree of market power at the processor and retail sector, and η is the retail demand price elasticity. The quota value identity equation does not exist in the model because there is no supply management in U.S.

4.1.3 Canada, EU and Brazil's Export Supply Equation Specification

In the current study, Canada, Brazil, and the EU are considered to be the main chicken and turkey exporting suppliers. Therefore, these countries' chicken and turkey export supply equations need to be estimated. As discussed in the previous chapter, export supply is estimated as a function of the export price and other exogenous variables. These exogenous variables include the exchange rate, production, policy variables and a time trend.

Canada's Chicken Export Supply Equation:

$$CAEX = ca1 + ca2 * CAEXP + ca3 * CAER + ca4 * TIME$$

Canada's Turkey Export Supply Equation:

$$TCAEX = uca1 + uca2 * TCAEXP + uca3 * TIME$$

EU's Chicken Export Supply Equation:

$$EUTRADE = eu1 + eu2 * EUEXP + eu3 * EUPDCK + eu4 * EUER + eu5 * TIME$$

EU's Turkey Export Supply Equation:

$$TEUTRADE = teu1 + teu2 * TEUEXP + teu3 * TEUPDCK + teu4 * TIME$$

Brazil's Chicken Export Supply Equation:

$$BRTRADE = ba1 + ba2 * BREXP + ba3 * BRCPI1 + ba4 * BRCPI2 + ba5 * BRCON + ba6 * TIME$$

Brazil's Turkey Export Supply Equation:

$$BRTRADE = uba1 + uba2 * TBREXP + uba3 * TBRPD + uba4 * TBRER + uba5 * TIME$$

The definitions of all the variables are listed in Appendices A and B. The coefficients on total production should be positive because more production may cause more excess supply in the export countries. The coefficients on exchange rates are supposed to be negative because the low exchange rate may increase the export quantities for the export countries. The coefficients of the export prices are expected to be positive in all export supply equations.

4.1.4 Russia, Japan and China Import Demand Equation Specification

As discussed in the previous sections, only single import demand equations need to be estimated for the Russian, Chinese and Japanese chicken markets. The net chicken import function is a function of chicken import prices and other exogenous variables, such as the exchange rate, real income, consumption, policy change, and a time trend as discussed in the previous chapter. The coefficients on the exchange rate and income levels are supposed to be positive because more income may increase the imports in the demand countries. The coefficients of the import prices for the import demand functions are expected to have negative signs. The coefficients on exchange rates are supposed to be positive because the high exchange rate may increase the import quantities of the importing countries. The specification of the equations is listed as follows:

Russian chicken import demand equation:

$$RUTRADE = ru1 + ru2 * RUIMP + ru3 * RUCON + ru4 * RUPDI$$

Japan's chicken import demand equation:

$$JATRADE = ja1 + ja2 * JAIMP + ja3 * JAER + ja4 * JATRF + ja5 * JAPDI + ja6 * JAPD$$

China's chicken import demand equation:

$$CHTRADE = cha1 + cha2 * CHIMP + cha3 * CHPDI + cha4 * CHPD + cha5 * CHTRF + cha6 * TIME$$

4.1.5 Mexico and Russian Import Demand Equation Specification

The Mexican and Russian turkey import demand equations are similar to the chicken equations and are defined as:

Mexico turkey import demand equation:

$$TMETRADE = uma1 + uma2 * TMEIMP + uma3 * TMEER + uma4 * TMETRF + uma5 * TIME$$

Russian turkey import demand equation:

$$RUITRADE = rua1 + rua2 * TRUIMP + rua3 * TRUER + rua4 * TRUTRF + rua5 * TIME$$

Again, the Mexican and Russian turkey import demand equations contain the endogenous variables of the turkey import prices of that country, and the exogenous variables of exchange rate, policy variables and time.

4.1.6 Price Linkage Equations Specification

To estimate the price relationships between the main trading countries, price linkage equations need to be defined and estimated. The twelve different original equations (equation systems) are linked by 11 price linkage equations. In the current study, U.S. chicken (turkey) export prices are regarded as world trade prices. Each linkage equation contains the own retail or import price of chicken (turkey) as a

dependent variable, and the world price (U.S. export price) as an independent variable. Furthermore, exchange rate, income, and policy variables are included as exogenous.

Canadian chicken and turkey price linkage equations:

$$CAEXP = ca41 + ca42 * USEXPCK + ca43 * CAPOLICY + ca44 * TIME$$

Due to supply management, there is no direct link between the Canadian domestic and world trade price. The Canadian export price is linked to the international market directly. Therefore, the Canadian trade price linkage equation is defined as a Canadian export price determined by the world poultry trade price (U.S. export price), and other exogenous variables, such as lagged dependent variables, a time trend and the export policy dummy variables.

EU, Brazil, China, Japan and Mexico chicken and turkey price linkage equation:

$$EURPCK = ea41 + ea42 * USEXPCK + ea43 * EUER + ea44 * EUPDI + ea45 * TIME$$

$$RUIMP = ru51 + ru52 * USEXPCK + ru53 * RUCPI + ru54 * RUPDI + ru55 * RUER$$

$$JAIMP = ja41 + ja42 * USEXPCK + ja43 * JATRF + ja44 * JACPI + ja45 * JAPDI + ja46 * TIME$$

$$CHIMP = ch41 + ch42 * USEXPCK + ch43 * CHTRF + ch44 * TIME$$

$$MEIMP = ma41 + ma42 * USEXPCK + ma43 * MEER + ma44 * MEPDI + ma45 * METRF$$

4.2 Statistical Tests

All the equations and variables need to be tested to establish if they are statistically significant and whether or not they fit the model. The tests are usually the: t-statistic, p-value, the R^2 statistic, the Durbin-Watson (DW) or Durbin-h test and the log of the likelihood function. The t-statistic is used to test the significance of the variables, the R^2 statistic tests the fitness of the data for the model, and the DW test is used to

examine the autocorrelation problem. The Durbin-Watson tests are not valid when the lagged dependent variable exists in the regression model. In this case, the Durbin *h*-test or Durbin *t*-test should be used to examine for autocorrelation. After the models for each country are estimated independently, a complete simulation model is built with all the trade identities. Trade policy simulation is conducted based on this estimated model. Five statistics are used to compare actual and simulated values: the mean of the simulated value, the correlation coefficient, the root mean square error, the percentage of the error due to bias, different variation and co-variation.

In the current study, the regional models for chicken (turkey) are estimated simultaneously. The low DW statistics in the original model (without adjusting for the errors) suggests that autocorrelation exist. Then the model containing RHO is modified to correct for autocorrelation for certain regional models. The original model:

$$Y_{it} = \alpha_1 X_{1t} + \alpha_2 * X_{2t} + \cdots \alpha_n * X_{nt}$$

After imposing the ρ (RHO) and lagged variables, it becomes

$$Y_{it} = \alpha_1 (X_{1t} - \rho X_{1t-1}) + \alpha_2 (X_{2t} - \rho X_{2t-1}) + \cdots \alpha_n (X_{nt} - \rho X_{nt-1}) + \rho Y_{it-1}$$

Then the performance of the original models can be improved by autocorrelation factors.

4.3 Regression Results

4.3.1 Estimation Results of the Canadian, U.S. and EU Chicken Models

Estimation results for the Canadian, U.S. and EU retail chicken demand, farm supply, processor demand and market power equations are shown in Tables 4.1, 4.2 and 4.3.

All retail demand equations have a good fit (R^2s are between 0.78 and 0.98). The retail chicken demand equations in Canada, the EU, and the U.S. have negative and significant (95 percent) own-price responses. The coefficients on the beef prices in the Canadian and EU models are positive. This coefficient in the EU chicken model is negative and significant. The turkey retail price coefficients in the Canadian and U.S. models are positive and significant at the 95% confidence level. These results indicate that turkey is a substitute product for chicken for the Canadian and U.S. consumers. The pork coefficients in the U.S and EU retail demand equations are positive, and in the Canadian model it is negative. This means that in Canada, a gross substitute relationship is evident between beef, turkey, and chicken and a gross complementary relationship between chicken and pork. In the U.S. a substitute relationship is evident between chicken and turkey, pork and beef. In the EU, all meat products represent substitute relationships with chicken. Income coefficients in those countries are all positive and significant at the 95 percent confident level. These results indicate that higher income could increase chicken consumption. Thus, one can draw the conclusion that chicken is a normal good.

The farm supply equation estimation results are shown in Tables 4.1-4.3. The farm prices in all three countries have positive relationships with their farm supply and all are significant at the 95% confidence level. The feed cost coefficients in the Canadian chicken model have positive signs but are not significant. The feed cost coefficients in the EU and U.S. models are negative. These results suggest that in Canada, the farmers are not sensitive to the feed cost. The coefficients of the lagged one-period farm supply variable all have positive signs and they are all significant at the 95% confident level.

For the input demand equation, the parameter estimation indicates positive signs of the two input price variables, and the input demand elasticities suggest a negative relationship between the raw material demand and the price.

In current study, the degree of market power is determined by equations. The specification of the market power equations are introduced in the previous sections. The regression results of the market power equations for the three countries' chicken markets are presented in Table 4.4. The degree of market power is calculated based on the parameter estimation of these equations. The parameter estimation results with standard errors are listed in Table 4.5. The significance of the market power parameters indicates that there are certain degrees of market power in all three countries' chicken industries.

4.3.2 Estimation Results of the Canadian and U.S. Turkey Models

The regression results of the Canadian and U.S. turkey model systems are presented in Tables 4.1 and 4.2. For both the Canadian and U.S. models, the retail turkey coefficients have negative and significant relationships with retail demand. In the Canadian turkey model, all coefficients except for the chicken price have negative signs. In the U.S. turkey model, all price coefficients are negative. The chicken price coefficient in the Canadian turkey model is positive and significant at a 95% confident level. This suggests that chicken is a substitute product for turkey in the Canadian market but not in the U.S. market. There are some reasons for this result. First, single demand equation are used for the current study. The symmetric property is not imposed in the demand model. Second, in reality, turkey is a special product for consumers, it is a more seasonal and holiday food especially during the Christmas. Consumers buy chicken products as well

when they purchase turkey. As opposed to the chicken model, the income coefficient in the Canadian model is positive but not statistically significant, which indicates that turkey consumption is not related to the income level in Canada, likely because it is a seasonal demand-meat during the Christmas and Thanksgiving periods.

The turkey farm supply equation estimation results are shown in Tables 4.1 and 4.2. Similar to the chicken models, the farm prices in all the three countries have positive relationships with their farm supply. The feed cost coefficients in the Canadian and U.S. models have negative signs with significance. These results indicate that turkey producers in the U.S. and Canada are sensitive to feed costs. The lagged farm supply variable significantly affects the dependent turkey farm supply variable. Thus, the behaviour of turkey farmers is affected by the last period's supply.

Similar to the chicken models, market power is estimated in the simultaneous equation systems. The conjectural elasticity is imposed as a function and examined in the Canadian and U.S. turkey market power equations. The results show that the parameters are significant in both the Canadian and U.S. turkey industries. The θ's estimation results with standard error suggest that oligopoly market power exists in the Canadian and U.S. turkey industries. Table 4.4 and 4.5 provide both regression and estimation results.

Table 4.1 Regression Results of Canadian Chicken and Turkey Models

	Canadian Chicken	*Canadian Turkey*
Estimator	ML	ML
Sample	1976-2001	1976-2001
Retail Demand Equation		
Constant (ca11)	.010176*	.454087E-02***
	(2.09986)	(10.4975)
Chicken Price (ca12)	-.351395E-04*	.271811E-05**
	(-3.85860)	(1.84288)
Turkey Price (ca13)	.274660E-04**	-.254043E-05*
	(2.03468)	(-1.67212)
Beef Price (ca14)	.356138E-05	-.347386E-06
	(1.08896)	(-.634831)
Pork Price (ca15)	-.361926E-06	-.104003E-05
	(-.062527)	(-1.31085)
Income (ca16)	.669748E-03***	.499299E-02
	(7.96060)	(.677065)
Farm Supply Equation		
Constant (ca31)	-301537	638861.***
	(-1.39764)	(3.56517)
Farm Marginal Cost (ca32)	708.055***	25.1123***
	(5.49642)	(4.16254)
Input Price1 (ca33)	3.40743	-51355.5**
(feed cost)	(1.50610)	(-3.33478)
Lagged Farm Supply (ca34)	.638904***	.596076***
	(8.53011)	(9.40040)
Processor Demand Equation		
(Input Demand Function)		
Constant (B1)	-774771***	30541.6***
	(-6.44101)	(2.8403)
CAW1*FPCK1 (BM1)	-4.77795***	.756951
	(-3.83133)	(1.63532)
CAW2*FPCK1(BM2)	.130073	.215696
	(1.02538)	(.400747)
Market Power Equation		
(Oligopoly Market Power)		
Constant (BMM)	4.62660***	1.37448***
	(6.57453)	(6.35985)
CAW2*CAW2(BKK)	8.99022***	2.04838
	(2.76069)	(.074226)
CAW3*CAW3(BLL)	.704481	10.4236
	(.706756)	(.353765)
CAW3*CAW2(BK2)	-1.85908	-8.71656
	(-1.12973)	(-.303142)
Adjusted R^2	0.98, 0.98, 0.97, 0.88	0.78, 0.95, 0.96, 0.97
D.W.	1.54, 1.56, 1.41, 1.54	1.99, 1.60, 1.62, 2.36
	with rho in the model	with rho in the model
Significant Level		*90% **95% ***99%

Table 4.2 Regression Results of U.S. Chicken and Turkey Models

	U.S. Chicken	*U.S. Turkey*
Estimator	ML	ML
Sample	1976-2001	1976-2001
Retail Demand Equation		
Constant (a11)	-.470130E-02	.910475E-02***
	(-.631965)	(15.1661)
Chicken Price (a12)	-.426765E-04***	-.457534E-05
	(-4.76042)	(-1.03058)
Turkey Price (a13)	.274063E-02**	-.372101E-04***
	(2.06563)	(-15.3649)
Beef Price (a14)	.864975E-05**	-.137753E-05**
	(2.50461)	(-.766711)
Pork Price (a15)	.260050E-05	-.928027E-05***
	(.530473)	(-4.32866)
Income (a16)	.605959E-03***	14.6517***
	(7.30064)	(8.12832)
Farm Supply Equation		
Constant (a31)	.129601E+07**	.128195E+07***
	(2.73946)	(5.69355)
Farm Price (a32)	1475.03*	34.2871***
	(1.83388)	(3.55546)
Input Price1 (a33)	-83528.6**	-34276.6***
(feed cost)	(-2.59861)	(-3.84843)
Lagged Farm Supply (a34)	.926150***	. .664576***
	(39.9854)	(11.0077)
Processor Demand Equation (Input Demand Function)		
Constant (D1)	-398075***	-156855***
	(-5.65123)	(-4.18066)
Input Prices1 (USBM1)	.569064***	.084351
	(8.36331)	(1.22206)
Input Prices2 (USBM2)	-.302465***	-.041606
	(-8.47728)	(-1.79206)
Market Power Equation (Oligopoly Market Power)		
Constant (USBMM)	1.28902***	1.35851***
	(41.9092)	(16.0182)
Input Prices (USBKK)	-6.90891	-9.80459**
	(-1.18350)	(-2.07860)
Input Prices (USBLL)	-11.7814	-.388652
	(-2.27387)	(-.808617)
Input Prices (USBK2)	10.0216*	3.63358**
	(1.78995)	(3.30309)
Adjusted R^2	0.99, 0.99, 0.99, 0.95	0.93, 0.98, 0.99, 0.96
D.W.	1.28, 1.60, 1.55, 1.58	1.39, 1.56, 2.10, 1.42
Significant Level	with rho in the model **90%	with rho in the model **95% ***99%

Table 4.3 Regression Results of EU Chicken Model

	EU Chicken
Estimator	ML
Sample	1976-2001
Retail Demand Equation	
Constant (ea11)	-.542313E-03
	(-.409643)
Chicken Price (ea12)	-.571344E-04***
	(-6.24199)
Beef Price (ea14)	.101632E-04***
	(3.38885)
Pork Price (ea15)	.373718E-04***
	(3.84698)
Income (ea16)	.370205***
	(11.6039)
Farm Supply Equation	
Constant (ea31)	.146665E+07**
	(3.37808)
Farm Price (ea32)	1477.82***
	(3.25073)
Input Price1 (ea33)	-59685.5
(feed cost)	(-1.63333)
Lagged Farm Supply (ea34)	.837487***
	(18.7042)
Processor Demand Equation (Input Demand Function)	
Constant (ED1)	.146159E+07*
	(4.14913)
Input Prices (EUBM1)	.440105***
	(5.52378)
Input Prices (EUBM2)	-.507635**
	(-2.99254)
Market Power Equation (Oligopoly Market Power)	
Constant (EUBMM)	.995584***
	(9.41248)
Input Prices (EUBKK)	-17.0991
	(-1.14621)
Input Prices (EUBLL)	-51.2887
	(-1.56917)
Input Prices (EUBK2)	32.5128
	(1.52125)
Adjusted R^2	0.96, 0.98, 0.98, 0.63
D.W.	1.79, 1.82, 1.32, 1.99
Significant Level	*90% **95% ***99%

Table 4.4 Oligopoly Market Power Equation Regression Results in Canadian, U.S. and EU Poultry Industries

Parameters	*Canadian Chicken*	*U.S. Chicken*	*EU Chicken*	*Canadian Turkey*	*U.S. Turkey*
Constant	-.079888 (-1.05862)	.340245*** (3.39554)	.249603* (1.68282)	.024042 (1.1405)	.743253** (13.7633)
Number of Firms	.7540E-06*** (1.42636)	.327E-02** (3.69896)	-.254452E-03 (-1.44116)	.1504E-07 (1.3223)	.5393E-06** (6.33903)
Net Trade	.1866E-06** (3.75623)	.284E-07** (3.49905)	-.919105E-08** (-2.67020)	-.011605* (-1.60559)	-.547E-02* (-1.98323)
Chapter 1 ime	N/A	-.042887*** (-3.61763)	N/A	N/A	-.016721** (-3.29109)

Table 4.5 Market Power Estimation Results based on the Market Power Equations (1976-2001 average)

	Estimate	*Standard Error*	*t-statistics*	*P-value*
Canadian Chicken Industry	0.12	0.06	2.01	0.044
Canadian Turkey Industry	0.15	0.04	3.63	0.001
U.S. Chicken Industry	0.08	0.02	2.78	0.005
U.S. Turkey Industry	0.06	0.037	1.77	0.076
EU Chicken Industry	0.06	0.16	0.42	0.674

4.3.3 Elasticities of the Current and Previous Models

Retail demand, retail supply and processor demand elasticities are presented in Table 4.6, which suggest that all of the retail demand equations have good signs on the own-price elasticities, and they are all significant at the 95% percent level of significance. In Canada, the own price elasticities are within the range of those previously reported (Table 4.7). However, the U.S. elasticities are large compared to the previous studies. This may be caused by the fact that the market power equation is imposed in the processor demand model and estimated with the retail demand equation simultaneously. The EU chicken own-price demand elasticity is inelastic as compared to *Alston's (1986)* result. This difference can be explained by changes in the estimation period. The farm

price elasticities in the table are long-run elasticities. They are all positive and significant. The farm price elasticities in the current study are within the range of previous studies reported. The processor demand own-input price elasticities are all negative and significant. This result is consistent with the theory that firms may decrease their production if the input price is high.

Table 4.6 Poultry Retail Demand, Supply and Processor Demand Elasticities

	Chicken Market			*Turkey Market*	
	Canada	**U.S.**	**EU**	**Canada**	**U.S.**
Retail Demand					
Chicken Price	-0.17*** (-1.94)	-0.17*** (-1.66822)	-0.32*** (-3.38)	0.10** (2.53)	-0.06 (-1.31)
Turkey Price	0.17 (1.35)	0.096** (2.06)	N/A	-.0.14** (-2.15)	-0.24*** (-3.76)
Beef Price	0.13 (1.45)	0.002** (2.19)	0.10 (1.55)	-0.015 (0.24)	-0.19** (2.26)
Pork Price	-0.08 (-0.94)	0.02 (-0.72)	0.0012*** (3.81)	-0.051 (-0.85)	-0.03 (-1.05)
Income	0.05 (0.59)	0.41*** (5.3)	0.003*** (13.05)	0.03 (0.52)	0.081 (1.00)
Farm Supply					
Farm Price	1.36*** (2.51)	0.90** (0.98)	0.30*** (3.76)	0.52*** (4.63)	0.28** (1.99)
Processor Demand					
Farm Price (live birds)	-0.14 (-0.57)	-0.07*** (-5.36)	-0.08*** (-4.42)	-0.09*** (-2.66)	-0.07** (-1.95)
Input Price1 (labour)	0.07* (1.68)	0.29*** (8.62)	0.10* (1.90)	0.15 (1.75)	0.23*** (4.60)
Input Price2 (electricity)	0.03 (0.29)	-0.13*** (-7.07)	0.06** (2.34)	0.035 (0.34)	-0.08* (-1.64)

Table 4.7 Previous Retail Demand and Supply Elasticities

	Chicken		*Turkey*
Own Price Elasticities		**Own Price Elasticities**	
Canada		**Canada**	
Coleman & Meilke (1988)	-0.015	Hahn (1992)	-0.21
Goddard (1991)	-0.135	Kooten (1988)	-0.95
Cranfield (1995)	-0.12 to -0.9	Moschini (1991)	-0.66
U.S.		**U.S.**	
Moschini & Meilke (1991)	-0.09	Brester & Schroeder (1995)	-0.33
Eales & Unnevehr (1988)	-0.124	Wohlgenant (1989)	-0.42
Cheney (2001)	-0.66	Harling & Thompson (1985)	-0.31 to -0.44
EU			
Alston (1986)	-0.5	Cheney (2001)	-0.128
Fousekis and Revell (2000)	-0.98		
Farm Supply Elasticities			
Canada		**U.S.**	
McNiel and Burbee (1983)	1.51	Haley (1990)	0.48
Fulton and Tang (1999)	1.28		
U.S.			
Haley (1990)	0.48		
Wohlgenant (1989)	1.18		

4.3.4 Estimation Results of Other Chicken Regional Models

Table 4.8 presents the regression results of other countries' import demand and export supply equations. The estimation results show that the coefficients of the three countries' import demand and export supply all have the expected signs, and they are all significant. The tariff rate parameter in Japan has negative and significant signs. This indicates that the import tariff rate of Japan plays a significant role in its chicken import sector. The Russian import price and exchange rate affects its chicken imports. Brazil's

chicken exports are more likely based on the export price level and the consumer price index changes caused by the dramatic increasing of the inflation rates. Except for the EU export price, the import tariff rate affects its exports significantly. The R^2 values of the three equations are large, and the DW statistics of the equations indicate that autocorrelation is not present.

Table 4.8 Regression Results of Other Countries' Chicken Models

	Brazil ***Export Supply***	***Canada*** ***Export Supply***	***EU*** ***Export Supply***	***Russia*** ***Import Demand***	***China*** ***Import Demand***	***Japan*** ***Import Demand***
Constant	.128E+08* (3.1178)	-148997** (-2.931)	-134525 (-.3741)	357205. (1.0697)	.264E+07* (2.7113)	121613 (.5576)
Export Prices	3837.81* (1.64)	21.1178** (2.3225)	139.81* (1.6707)	N/A	N/A	N/A
Import Prices	N/A	N/A	N/A	-9021.*** (-4.6365)	-10789.** (-2.1373)	-716.437* (-1.6095)
Exchange Rate	-1450.47** (-3.1301)			-48019*** (-3.6500)		
Import Tariff	N/A	4484.58 (.0764)	-12479* (-1.6335)	N/A	34750.9 (.0778)	-17733** (-2.5529)
Production	N/A		.031945 (1.0238)	N/A	73.2974 (2.0751)	293.507** (2.1329)
Consumer Price Index	-357825* (-1.7078)					
Statistics						
R^2	0.96	0.94	0.69	0.88	0.76	0.97
D-W	2.31	1.62	1.71	2.09	2.03	1.57

4.3.5 Estimation Results of Other Countries' Turkey Models

Table 4.9 presents the regression results of the other main turkey trading countries. Canada, Brazil and the EU's export supply functions have positive signs on the export prices. The two coefficients in the Brazilian and EU models are significant, and in the Canadian model it is insignificant. In the EU, the effect of turkey production on

exports is positive, and this variable is significant at the 95 percent level of significance in the EU equation. Brazil's exchange rate coefficient is positive and significant.

The Mexican and Russian estimation results suggest that import tariff rates in these two countries have significant impacts on their imports. Since dummy variables are created and imposed in the model, the two parameters are positive. The Mexican import tariff rate affects the import demand significantly, as well.

Table 4.9 Regression Results of Other Countries' Turkey Models

	Canada ***Export Supply***	***Brazil*** ***Export Supply***	***EU*** ***Export Supply***	***Mexico*** ***Import Demand***	***Russia*** ***Import Demand***
Constant	19635.9 (.9996)	-119903. (-1.4713)	-2520 (-1.0974)	253304 (4.4462)	-26157.4** (-2.0229)
Export Prices	.11450 (1.3397)	87.7269* (1.7106)	.3642E-02* (1.6849)	N/A	N/A
Import Prices	N/A	N/A	N/A	-31.9834 (-1.5143)	-10776.7* (-1.6468)
Import Tariff	N/A	N/A	N/A	48058.0*** (6.0365)	35222.5 (1.5767)
Production	N/A	N/A	107.290* (1.6757)	N/A	N/A
Exchange Rate	N/A	596519*** (4.6347)	194.225 (1.3378)	48058*** (6.0365)	3411.94*** (2.8516)
Time	-332231 (-.7017)	N/A	10646.8*** (3.7139)	-1939.85 (-1.1793)	16796.6*** (2.7570)
Statistics **R2** **D-W**	 0.41 1.12	 0.74 1.92	 0.93 2.13	 0.99 2.51	 0.96 1.52

4.3.6 Price Linkage Equations

The twelve different regional models are linked together by eleven price linkage equations. Each linkage equation contains the own retail prices of chicken (turkey) as dependent variables, and world price (U.S. export price) and policy variables (U.S. EU export subsidies, Russian, Mexico, China and Japan's import tariff rate, inflation rate) as

independent variables. Some other variables such as the exchange rate and time trend may affect the retail price values are also included in price linkage equations.

Tables 4.10 and 4.11 present the estimation results, including coefficients and statistics, for each price linkage equation. The significance of all the F-statistics implies that the coefficients are jointly significant. Except for the Mexican equation, the R^2 values are all high. The DW statistics suggest that autocorrelation is not present in these linkage equations.

Table 4.10 Chicken Price Linkage Equation Estimation Results

	Coefficients			*Statistics*		
	World Price	**Exchange Rate**	**Policy**	**F**	**R^2**	**D-W**
Canada	0.45*	-16.06**	--	79*	0.80	1.48
	(1.83)	(-2.30)				
EU	0.49**	-143.5***	0.45***	80*	0.90	1.28
	(1.72)	(-6.33)	(2.78)			
Brazil	0.42*	---	3.33*	80*	0.46	2.25
	(1.80)		(1.80)			
Russia	0.02*	---	57.23**	76*	0.58	2.29
	(1.62)		(2.25)			
China	0.82***	---	92.6***	78*	0.91	1.73
	(4.13)		(6.62)			
Japan	0.93*	---	-5.61**	87*	0.78	1.83
	(1.69)		(-2.22)			

(*, **, and ** indicated significant at 10, 5, 1 percent level, respectively)

Table 4.11 Turkey Price Linkage Equation Estimation Results

	Coefficients			*Statistics*		
	World Price	**Exchange Rate**	**Policy**	**F**	**R^2**	**D-W**
Canada	1.02*	-65.79**	---	70*	0.46	2.19
	(1.89)	(-2.11)				
EU	0.56		-0.02**	83*	0.93	2.08
	(0.90)		(-3.16)			
Brazil	1.15	-49.49*	---	83*	0.46	1.72
	(1.32)	(-1.53)				
Mexico	-1.17*	-6.95	---	75*	0.32	1.58
	(-1.81)	(-1.19)				
Russia	0.012	10.55	---	82*	0.97	1.86
	(0.06)	(0.86)				

(*, **, and *** indicated significant at 10, 5, 1 percent level, respectively)

4.4 Statistical Tests Results

As introduced in the previous sections, all of the regional models for chicken (turkey) are estimated simultaneously. For each country, the statistics are listed in the regression result tables. The Durbin-Watson test is a used to test for autocorrelation. When lagged variables exit in the equations, the Durbin *h*-test or Durbin *t*-test can be used to test for autocorrelation.

Table 4.12 Durbin Watson Statistics in Simultaneous Equation Systems without Imposing ρ (RHO)

Model System	*Retail Demand*		*Processor Demand*		*Farm Supply Equation*		*Market Power*	
	D-W	R^2	D-W	R^2	D-W	R^2	D-W	R^2
Canadian Chicken	1.18	0.98	0.90	0.98	1.66	0.97	0.83	0.92
U.S. Chicken	1.28	0.98	1.59	0.98	1.55	0.99	1.58	0.98
EU Chicken	1.79	0.95	1.82	0.97	1.31	0.98	1.99	0.63
Canadian Turkey	0.75	0.93	1.33	0.96	0.83	0.92	1.33	0.96
U.S. Turkey	1.39	0.93	1.56	0.98	2.10	0.99	1.41	0.96

The DW statistics suggest that autocorrelation errors exist in some of the system equations. For correcting the autocorrelation problems, ρ (RHOS) are imposed in the equations with low DW values. Table 4.13 presents the Durbin Watson statistics after imposing the autocorrelation correction factor. ρ (RHOS) are imposed in the Canadian chicken and turkey system equations and estimated. The model with autocorrelation correction factors performs better since DW values move close to 2 and the RHOs are all statistically significant (Table 4.13).

Table 4.13 Durbin Watson Statistics in Simultaneous Equation Systems after Imposing ρ (RHO)

Model System	*RHO*	*Retail Demand*		*Processor Demand*		*Farm Supply*		*Market Power*	
		D-W	R^2	D-W	R^2	D-W	R^2	D-W	R^2
Canadian Chicken	0.47*	1.54	0.98	1.56	0.98	1.41	0.98	1.54	0.88
Canadian Turkey	0.62*	1.99	0.78	1.60	0.95	1.62	0.96	2.36	0.97

All the other t-statistics on the RHO coefficients indicate significance, so it is useful to determine the significance of these autocorrelation correction factors within the estimated system of equations. Thus, the following hypothesis is formulated and tested.

$$H_0 : \rho = 0;$$
$$H_1 : \rho \neq 0.$$

H_0 tests the hypotheses that RHO has no effect on the estimation, and it does not correct the autocorrelation errors. The null hypotheses H_1 tests against the alternative hypothesis, which means the autocorrelation factor affects the model estimation results significantly.

Testing the above parameter hypotheses is done with a Log Likelihood Ratio Test. This test measures the changes in the log of the likelihood function from before and after the restrictions are imposed. This test is performed by the calculation of the Chi-squared statistic with degrees of freedom equal to the number of restrictions. The test statistics formula is given by:

$$L = -2 * (LLR_R - LLR_U) \sim \chi^2_M$$

where LLR_R = restricted log of the likelihood
LLR_U = unrestricted log of the likelihood

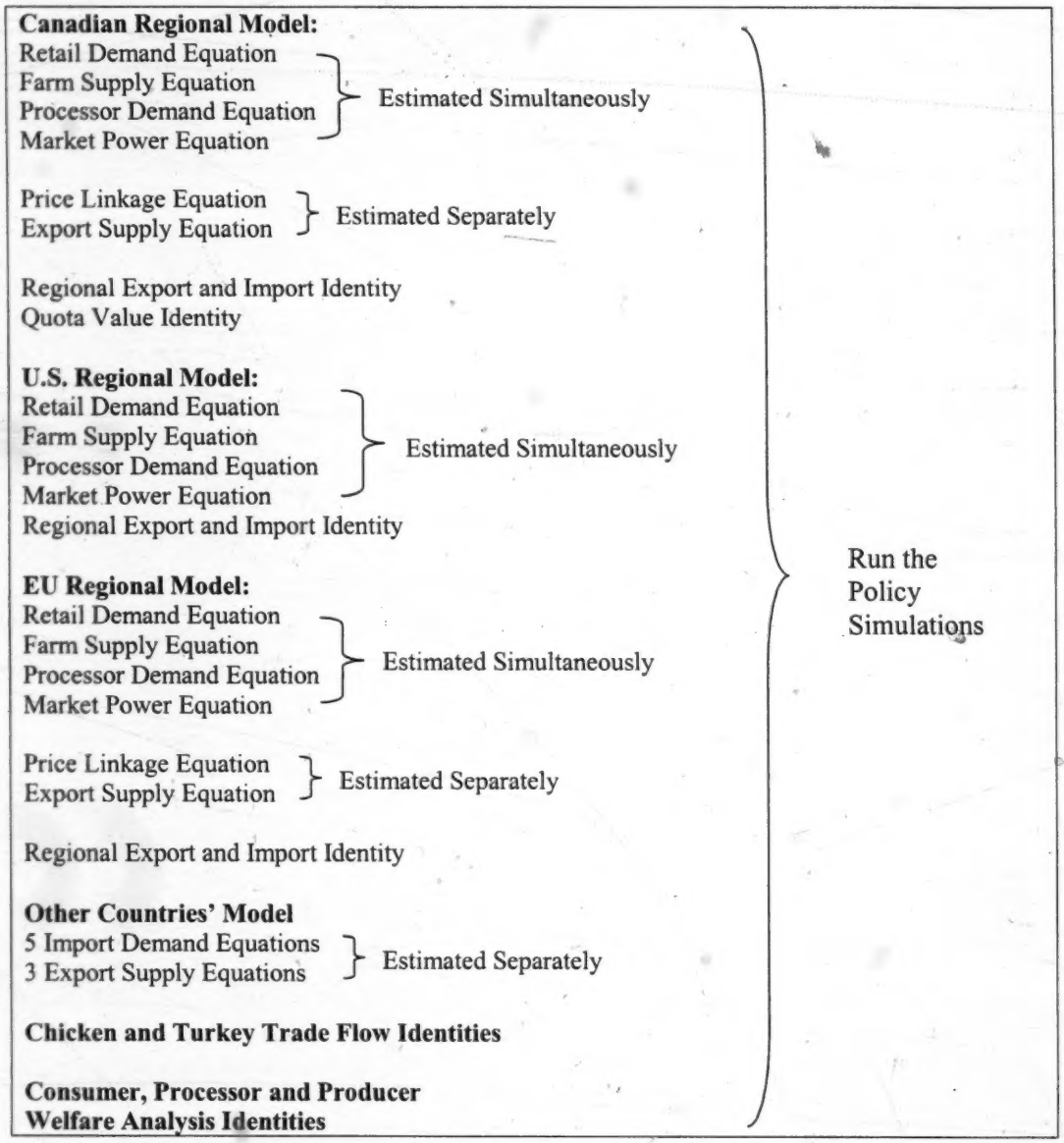
The likelihood ratio test results show that the test statistics are larger than the critical value at the 95 percent level of significance in the Canadian chicken and turkey model. Therefore, the RHO's affect on the estimation is significant in these model systems, which is consistent with the t-statistics result.

Table 4.14 Likelihood Ratio Test Statistics for Imposing the Autocorrelation Correction Factor

Model System	LLR_R	LLR_U	M	X^2
Canadian Chicken	-556.226	-550.142	1	12.16
Canadian Turkey	-392.026	-387.829	1	8.39

4.5 Model Summary

Table 4.15 Model Summary



In the current study, regional models of the Canadian, U.S. and EU chicken industries, and the Canadian and U.S. turkey industries are estimated. Each regional model contains four equations (consumer demand, processor demand, farm supply,

oligopoly power equations) and two identities. The Canadian model has one more identity, which is the farm production quota value identity. The endogenous variables in the regional model are: retail demand, retail price, processor demand, farm prices (for U.S. and EU), farm marginal cost and quota values (for Canada), farm supply, net trade, and export prices (for Canada model only).

Eleven import demand and export supply equations and 11 price linkage equations are estimated. There are two international trade identities (one is for chicken, the other is for turkey) in the whole trade model system for closing the model. Fifteen identities for estimating the Canadian, U.S. and EU consumer, processor and producer welfares are also included in the model.

4.6 Validation Statistics

The procedure of obtaining a model solution by means of an iterative method is called model simulation. There are two kinds of simulation: deterministic and stochastic. Simulations that abstract from the stochastic character of the model are called deterministic. This simulation is calculated based on the estimated regression model. Simulations allowing for the effects of random shocks to model equations are called stochastic simulations. They consist of repetitive model solving, each time with a new set of generated random shocks. These shocks are usually introduced as additive disturbances or added to equation parameters. In the current study, deterministic simulation is used since all the simulation calculations are based on the regression results.

To estimate how the simulation model performs, validation statistics need to be determined for the complete model. This section discusses the validation statistics for the

base model and the policy simulation model. These statistics are: Correlation Coefficient, Root Mean Square Error, Percent Root Mean Square, and RMSE Mean *(Theil, 1966)*. The concepts of these statistics are introduced in the previous section. The listing of every endogenous variable and its statistics are presented in Table 4.16.

4.6.1 Correlation Co-efficient Statistics

Table 4.16 provides the correlation coefficients between the actual and predicted values. Most of the statistics suggest that the predicted values move in same direction with actual values. The Mexican turkey import price and U.S. chicken farm price are the only two variables with negative correlation coefficients; 5 of the correlation coefficients are between 0 and 0.5, while the remaining 17 have correlation coefficients greater than 0.5.

However, the correlation coefficients only measure how closely the actual and predicted values move together. Other statistics, such as Root Mean Square Error, can be used to provide more information on the quality of the model.

4.6.2 Root Mean Squared Error

The Root Mean Square Error (RMSE) provides a measure of the deviation of the predicted values from the actual values. Usually, the more accurate the prediction, the lower the RMSE statistics. The value of the RMSE statistics also depends on the scales of the variables. Table 4.16 provides the RMSE for the simulation. The estimation results show that all the RMSE are good in terms of the variables. However, RMSE provides a measure of the average error, and it does not provide a significant amount of information

in itself. Percentage Root Mean Squared Error provides such a measure, and is discussed next.

4.6.3 Percentage Root Mean Squared Error

Percentage Root Mean Square Error (PRMSE) relates the RMSE to the mean of the actual data. PRMSE can be used to interpret the errors by percentage. The larger the PRMSE, the greater the deviation from actual values. Table 4.16 presents the PRMSE estimation results of this study. 32 variables have PRMSE less than 20%, and 12 have PRMSE between 20% and 100%. This suggests that there is almost no large (more than 100%) value of the PRMSE statistics for the current simulation and the prediction errors are not significant.

4.6.4 Mean Square Error Decomposition

The RMSE and PRMSE measure the prediction error in a simulation model. The Mean Square Error Decomposition can break a prediction into three different components that can provide the measure of systematic and non-systematic error. As such, MSE is composed of three error terms: MSE due to Bias, Variance and Covariance. The MSE due to bias measures how much of the MSE is accounted for by systematic error in the simulation. A large MSE due to bias (greater than 0.1 or 0.2) is considered to indicate that systematic bias is present. The MSE due to variance measures the accuracy of the prediction of the variances. If this value equals 0, then the simulation perfectly predicts the variance of the actual data. MSE due to covariance measures how much of the MSE

is due to unsystematic error. Ideally, the bias and variance approach zero, while the covariance approaches one.

Table 4.16 presents the measures of: MSE due to Bias, Variance and Covariance. Twenty-three (53%) of the endogenous variables have bias measures lower than 0.2, while the remaining are greater than 0.2. Twenty-three (53%) of the endogenous variables have variances lower than 0.2, and others are greater than 0.2. Eight (18%) have covariances greater than 0.7, and the remaining are lower than 0.7.

The average of bias measures in this study is 0.27; the whole mean variance is 0.26, and covariance 0.46. Based on the MSE Decomposition, the bias and variance measures are a little higher than expected, but it suggests that the performance of the model is acceptable.

Table 4.16 Validation Statistics of Policy Simulation Model

	Correlation Coefficient (R)	*Root Mean Squared Root (RMSE)*	*Percent Root Mean Square Error (PRMSE)*	*MSE due to Bias*
CARDCK	0.97	0.53E-03	0.02	0.02
CARPCK	0.92	9.35	0.05	0.01
CAPDCK	0.98	48086.8	0.03	0.04
CAQV	0.38	5.55	0.44	0.10
CAFMC	0.67	5.55	0.10	0.10
CARSCK	0.92	49941.5	0.06	0.10
CAEXP	0.75	9.08	0.09	0.02
USRDCK	0.98	0.65E-03	0.02	0.49
USRPCK	0.86	8.13	0.05	0.59
USPDCK	0.98	424497	0.02	0.17
USFPCK	0.18	5.51	0.25	0.43
USRSCK	0.98	353736	0.03	0.02
USTRADE	0.94	252791	0.14	0.78E-04
EURDCK	0.88	0.0052	0.025	0.07
EURPCK	0.76	14.47	0.08	0.0074
EUPDCK	0.93	279715	0.03	0.03
EUFPCK	0.61	8.22	0.22	0.03
EUTRADE	0.81	56077	0.15	0.04
EURSCK	0.86	307510	0.04	0.0006
JAIMP	0.92	11.45	0.06	0.20
JATRADE	0.96	43521	0.09	0.0017
CHIMP	0.95	4.49	0.05	0.007
CHTRADE	0.85	72817	0.35	0.0039
RUIMP	0.97	7.12	0.07	0.008
RUTRADE	0.92	130745	0.52	0.0068
BREXP	0.71	11.28	0.10	0.022
BREX	0.51	232632	0.38	0.0023
TCARDCK	-0.07	0.93E-04	0.02	0.13
CARPTUR	0.94	19.11	0.12	0.75
TCAPDCK	0.96	5105	0.01	0.27
TCAQV1	0.20	16.30	0.38	0.06
TCAFMC	0.50	16.30	0.12	0.06
TCARSCK	0.74	5202	0.04	0.04
TCAEXP	0.58	12.49	0.12	0.038
TRDCK	0.41	0.0019	0.02	0.08
RPTUR	0.88	5.48	0.03	0.04
TPDCK	0.97	51350	0.01	0.097
TFPCK	0.60	3.63	0.13	0.034
TRSCK	0.96	43366	0.02	0.04
USTTRADE	0.82	57197	0.82	0.0071
TMAIMP	0.32	0.34	0.018	0.018
TMATRADE	0.99	1775	0.08	0.01
TRUIMP	0.82	9.52	0.12	0.024
TRUTRADE	0.98	11931	0.28	0.02
TEUTRADE	0.97	13111	0.15	0.023
TEUEXP	0.98	7.21	0.05	0.012

Table 4.16 Validation Statistics of Policy Simulation Model

	MSE due to Bias	*MSE due to Different Variation*	*MSE due to Different Co-variation*
CARDCK	0.02	0.07	0.90
CARPCK	0.01	0.0043	0.98
CAPDCK	0.04	0.008	0.95
CAQV	0.10	0.29	0.59
CAFMC	0.10	0.17	0.71
CARSCK	0.10	0.004	0.89
CAEXP	0.02	0.31	0.65
USRDCK	0.49	0.10	0.40
USRPCK	0.59	0.03	0.96
USPDCK	0.17	0.006	0.82
USFPCK	0.43	0.24	0.31
USRSCK	0.02	0.003	0.97
USTRADE	0.78E-04	0.056	0.14
EURDCK	0.07	0.001	0.92
EURPCK	0.0074	0.34	0.65
EUPDCK	0.03	0.018	0.96
EUFPCK	0.03	0.03	0.93
EUTRADE	0.04	0.07	0.88
EURSCK	0.0006	0.12	0.87
JAIMP	0.20	0.05	0.73
JATRADE	0.0017	0.34	0.64
CHIMP	0.007	0.05	0.94
CHTRADE	0.0039	0.08	0.91
RUIMP	0.008	0.064	0.99
RUTRADE	0.0068	0.06	0.93
BREXP	0.022	0.13	0.86
BREX	0.0023	0.45	0.54
TCARDCK	0.13	0.27	0.59
CARPTUR	0.75	0.05	0.18
TCAPDCK	0.27	0.04	0.68
TCAQV1	0.06	0.78	0.16
TCAFMC	0.06	0.66	0.27
TCARSCK	0.04	0.02	0.94
TCAEXP	0.038	0.45	0.53
TRDCK	0.08	0.24	0.67
RPTUR	0.04	0.01	0.94
TPDCK	0.097	0.07	0.82
TFPCK	0.034	0.54	0.42
TRSCK	0.04	0.05	0.89
USTTRADE	0.0071	0.25	0.74
TMAIMP	0.018	0.42	0.57
TMATRADE	0.01	0.02	0.96
TRUIMP	0.024	0.49	0.50
TRUTRADE	0.02	0.03	0.94
TEUTRADE	0.023	0.01	0.97
TEUEXP	0.012	0.09	0.89

4.7 Summary and Discussion

One objective of this chapter was to estimate the econometric model of the international chicken and turkey industries. Regional models system equations were estimated depending on different market structures. Market power was tested for the Canadian, U.S. and EU poultry industries. In addition, a few identities for closing the model and analyzing the welfare changes were defined. For the most part, the estimated parameters were all with expected signs and significant. The results suggest oligopoly market power exists in the Canadian, U.S. and EU chicken, and the Canadian and U.S. turkey industries.

Statistical tests based on the model were conducted to indicate the performance of the regional models. A Likelihood Ratio test between autocorrelation corrected functions (with RHO) and original models (without RHO) indicated that the autocorrelation correction factor is significant. Furthermore, it improves the performance of the model.

The validation statistics were presented and discussed in the last section. Various measures of the simulation model's performance were reported. Correlation coefficients suggest a close relationship between the actual and predicted data. The Root Mean Square Error and Percentage Root Mean Squared Error indicate the acceptable error of the prediction. However, MSE Decomposition shows the systematic error in the simulation is considered to be large. The short simulation period (12 years) can be used to explain it.

In the next chapter, a simulation will be used to evaluate the impact of the different policies on the Canadian and international poultry industries.

CHAPTER 5

POLICY SIMULATION RESULTS

One of the objectives of this study is to examine the impact of different trade policies on the Canadian poultry market. These policies are from main poultry exporters and affect world poultry market significantly. Based on the policy review information, export subsidies from the U.S. and EU, and Canadian poultry export policies are chosen. In this chapter, policy simulations are conducted to identify these impacts.

In support of the U.S. export subsidy analysis, the simulation results of a model that excludes export subsidies are compared with the base model results to investigate its impacts on the market. Theoretically, the EU export subsidy has the same impact on the international poultry markets as the U.S. subsidy. The impact of the EU export subsidy is estimated with the same approach. For the Canadian export policy, the simulated results based on the complete removal of total Canadian poultry exports are used to provide a comparison with the base model simulation results. The Canadian, EU and U.S. consumer, processor and producer welfare changes are also estimated under each scenario. These simulations are conducted for models with market power (MP) and models assumed to have no market power (NMP). The reason for taking this approach is to analyze the policy shocks on markets with different market structures.

5.1 The U.S. Export Subsidy Removal Simulation Results

Prior to 2001, the U.S. was subsidizing its poultry exports, but this subsidization was subsequently terminated. In this section, the simulation results of the impact of the U.S. export subsidies between 1989 and 2001 are presented. In the current study, the

world trade price (the U.S. export price) is calculated by decreasing the U.S. domestic retail price by subsidized values per kilogram (Figure 5.1 and Table 5.1). The simulations are conducted with and without market power relationships.

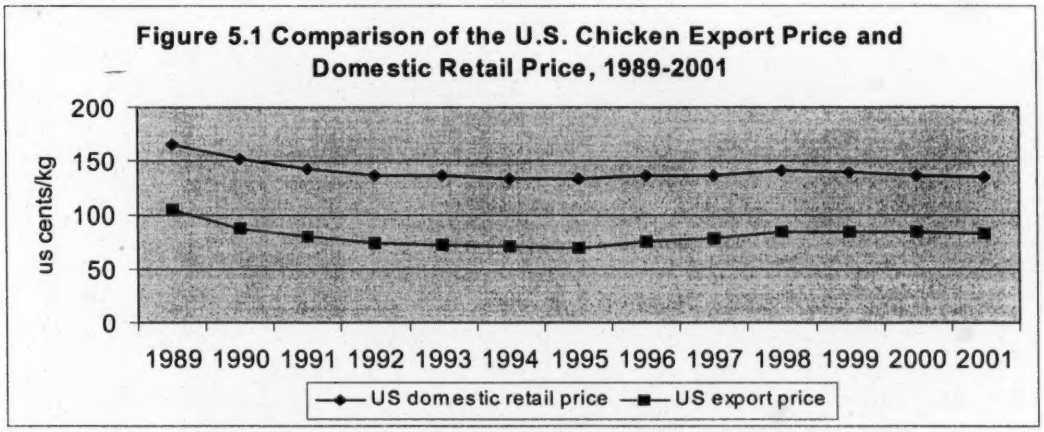


Figure 5.1 Comparison of the U.S. Chicken Export Price and Domestic Retail Price, 1989-2001
us cents/kg
200
150
100
50
0
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001
US domestic retail price
US export price

(Source: USDA, Livestock and Poultry: World Market and Trade Circular Archives, 2001; OECD[2], DSI Database, 2002)

Table 5.1 The U.S. Chicken Export Subsidies from 1989-2001

Year	*Quantities*	*Value*	*Cents/kg*
1989	6556	3882	59.21
1990	43636	27273	62.51
1991	38273	23920	62.49
1992	34818	21761	62.50
1993	36455	22784	62.49
1994	35636	22273	62.50
1995	34196	21377	62.51
1996	32955	20013	60.72
1997	31715	18648	58.79
1998	30475	17284	56.72
1999	29235	15919	54.45
2000	27994	14555	51.93
2001	27994	14558	52.00

(Source: USDA, Livestock and Poultry: World Market and Trade Circular Archives, 2001; OECD, DSI Database, 2002)

[2] Organization for Economic Co-operation and Development.

5.1.1 The U.S. Chicken Export Subsidy

5.1.1.1 Removal of the U.S. Chicken Export Subsidy – Impact on Chicken Market

The U.S. was subsidizing its poultry exports in the international market before 2001, which can be proved by taking the difference between the U.S. domestic retail and export prices. Since the U.S. is the largest poultry exporter in the world, any policy that affects its exports may significantly affect the world market. The following sections show the simulation results of the impact of the U.S. export subsidies on the international chicken market.

Table 5.2-1 displays the U.S. chicken export subsidy simulation results. After removing the U.S. chicken export subsidy, the U.S. chicken retail price decreases by 1.58% (MP) and 2.64% (NMP), and retail demand increases by 0.47% (MP) and 0.48% (NMP). The removal of the export policy also affects the other endogenous variables: processor demand drops by 2.52% (MP) and 2.25% (NMP), farm price drops by 6.94% (MP) and 4.66% (NMP), and retail supply decreases by 2.19% (MP) and 1.89% (NMP). The U.S. export subsidy also influences the trade markets of other main trade players, such as the EU, Canada, Brazil, Russia, China, and Japan. Both the EU and Brazilian chicken export prices and quantities increase after removal of the U.S. chicken export subsidy. The three main chicken importers, Russia, Japan and China, would not import as much as in the subsidized market. They decrease their import volumes due to the higher import price. The above results clearly show that the existence of the U.S. chicken export subsidy decreases total exports of other competitors. As a result, the U.S. export price decreases and the U.S. realizes a higher export market share within the international chicken market.

As a result of the supply management program, Canada's retail price and retail demand are not affected by the U.S. export subsidy. Canadian imports are also considered constant under certain trade agreements. The simulation results suggest that without the U.S. chicken export subsidy, the Canadian chicken export price increases by 22.67% (MP) and 27.67% (NMP), and total chicken exports from Canada increase by 61.84% (MP) and 54.45% (NMP).

Table 5.2-1 Chicken Market Simulation Results after Removal of the U.S. Export Subsidy- Impact on Chicken Market (1990-2001 Average)

International Chicken Market	Canada	U.S.	EU	Canada	U.S.	EU
	(with market power)			(without market power)		
Retail Price						
Base	90.97	141.24	174.85	90.97	95.37	82.42
Shocked	193.41	138.99	176.11	90.97	92.90	83.90
% Difference	0.00%	-1.58%	0.71%	0.00%	-2.64%	1.93%
Retail Demand						
Base	7.43E+05	9.60E+06	7.16E+06	8.49E+05	1.04E+07	8.67E+06
Shocked	7.43E+05	9.65E+06	7.14E+06	8.49E+05	1.05E+07	8.65E+06
% Difference	0.00%	0.47%	-0.29%	0.00%	0.48%	-0.28%
Processor Demand						
Base	1945417	1.55E+07	9.83E+06	2202890	1.69E+07	1.18E+07
Shocked	1983108	1.51E+07	9.91E+06	2240435	1.65E+07	1.19E+07
% Difference	1.96%	-2.52%	0.80%	1.72%	-2.25%	0.62%
Farm Price						
Base	N/A	26.60	50.44	N/A	33.75	79.74
Shocked	N/A	24.69	51.64	N/A	31.88	80.86
% Difference	N/A	-6.94%	2.41%	N/A	-4.66%	1.43%
Farm Marginal Cost						
Base	56.62	N/A	N/A	64.51	N/A	N/A
Shocked	57.76	N/A	N/A	65.65	N/A	N/A
% Difference	1.97%	N/A	N/A	1.69%	N/A	N/A
Farm Quota Price						
Base	10.62	N/A	N/A	2.73	N/A	N/A
Shocked	9.48	N/A	N/A	1.60	N/A	N/A
% Difference	-24%	N/A	N/A	-65%	N/A	N/A
Retail Supply						
Base	734549	11296381	7635044	842588	12390898	9389615
Shocked	750382	10989131	7708489	858359	12099017	9455798
% Difference	2.19%	-2.79%	0.95%	1.89%	-2.38%	0.69%

Export Price						
Base	104.93	N/A	121.13	85.85	N/A	98.61
Shocked	128.60	N/A	149.06	109.42	N/A	126.43
% Difference	22.67%	N/A	23.65%	27.67%	N/A	29.26%
Net Trade						
Base	31402	1541920	427687	37058	1736599	426442
Shocked	45350	1220029	509931	51606	1416199	508224
% Difference	61.84%	-27.22%	19.41%	54.45%	-22.09%	19.44%
Producer Surplus						
Base	6.32E+07	2.18E+08	4.65E+08	7.14E+07	2.91E+08	8.07E+08
Shocked	6.44E+07	2.00E+08	4.78E+08	7.26E+07	2.71E+08	8.22E+08
% Difference	1.97%	-9.15%	2.84%	1.69%	-6.70%	1.79%
Processor Profits						
Base	3.75E+08	2.41E+09	1.76E+09	2.01E+08	1.79E+09	9.83E+08
Shocked	3.84E+08	2.28E+09	1.81E+09	2.06E+08	1.69E+09	1.03E+09
% Difference	2.62%	-5.78%	2.85%	2.69%	-6.35%	4.88%
Consumer Surplus						
Base	6.75	15.76	4.42	9.14	18.02	6.50
Shocked	6.75	15.86	4.40	9.14	18.14	6.46
% Difference	0.00%	0.76%	-0.58%	0.00%	1.79%	-0.57%

Import Country	**Japan**	**China**	**Russia**	**Japan**	**China**	**Russia**
	with market power			without market power		
Import Prices						
Base	201.07	93.71	124.69	134.58	88.92	123.60
Shocked	283.64	99.51	126.06	216.80	94.70	124.96
% Difference	41.61%	6.00%	1.22%	63.34%	6.32%	1.23%
Net Imports						
Base	526800	340613	499526	574438	392220	505875
Shocked	467645	277961	546996	515534	329894	484018
% Difference	-11.57%	-23.30%	-16.17%	-10.49%	-17.96%	-23.97%

Export Country	**Brazil**	**Brazil**
Export Prices	with market power	without market power
Base	119.87	105.46
Shocked	137.73	123.24
% Difference	14.78%	16.79%
Net Exports		
Base	569311	496172
Shocked	660856	587363
% Difference	16.34%	18.85%

5.1.1.2 Removal of the U.S. Chicken Export Subsidy – Impact on Turkey Market

In this study, the cross-effects of the U.S. chicken export subsidy impacts on the turkey market are also examined. Detailed information is provided in Table 5.2-2.

As compared with chicken, the turkey market is relatively small. The U.S. chicken export subsidy does not have a noticeable impact on the turkey market. Under an oligopoly market structure, the removal of the chicken export subsidy leads to a decrease in the U.S. turkey retail price by 0.18%; retail demand increases by 0.24%; and net exports of U.S. turkey decrease by 0.63%. Under a perfectly competitive market, the removal of the U.S. chicken export subsidy leads to a decrease in the turkey retail price by 0.06%; the U.S. retail demand for turkey increases 0.25%; and net exports of U.S. turkey decrease by 0.04%. The other main turkey exporters (Canada, EU, and Brazil) are all shown as increasing their export prices. The Russian and Mexican simulation results indicate decreases of their imports. Therefore, one can conclude that the U.S. chicken export subsidy improves not only its chicken exports but also turkey exports.

Similar to the chicken market, the U.S. chicken export subsidies do not impact the Canadian turkey retail price and demand because of supply management. The Canadian turkey export price increases by 0.18% (MP) and 0.10% (NMP), and Canadian total turkey exports increase by 0.05% (MP) and 0.01% (NMP).

Table 5.2-2 Chicken Market Simulation Results after Removal of the U.S. Export Subsidy –Impact on Turkey Market (1990-2001 Average)

International Turkey Market	**Canada**	**U.S.**	**Canada**	**U.S.**
	with market power		without market power	
Retail Price				
Base	143.44	144.61	80.36	66.22
Shocked	143.44	144.88	80.36	66.31
% Difference	0.00%	0.18%	0.00%	0.06%

Retail Demand				
Base	129279	2116290	128683	2935190
Shocked	129279	2121342	128683	2942597
% Difference	0.00%	0.24%	0.00%	0.25%
Processor Demand				
Base	273836	2935626	268947	4238554
Shocked	273848	2941614	268950	4248213
% Difference	0.0044%	0.20%	0.0013%	0.22%
Farm Price				
Base	N/A	27.04	N/A	56.24
Shocked	N/A	27.18	N/A	56.47
% Difference	N/A	0.49%	N/A	0.37%
Farm Marginal Cost				
Base	78.02	N/A	74.47	N/A
Shocked	78.03	N/A	74.47	N/A
% Difference	0.01%	N/A	0.003%	N/A
Quota Value				
Base	7.98	N/A	11.54	N/A
Shocked	7.97	N/A	11.53	N/A
% Difference	-0.11%	N/A	-0.02%	N/A
Retail Supply				
Base	136533	2286110	134060	3246425
Shocked	136539	2290521	134062	3253547
% Difference	0.004%	0.19%	0.001%	0.22%
Export (Import) Price				
Base	86.95	N/A	40.96	N/A
Shocked	87.12	N/A	41.02	N/A
% Difference	0.18%	N/A	0.10%	N/A
Net Trade				
Base	10709	154921	8901	341125
Shocked	10715	154501	8903	341149
% Difference	0.05%	-0.63%	0.01%	-0.04%
Producer Surplus				
Base	17658075	72357683	16846075	184804167
Shocked	17659992	72805850	16846608	185783333
% Difference	0.0094%	0.60%	0.0011%	0.51%
Processor Profits				
Base	265517833	409173667	158484333	590338500
Shocked	270414083	410009000	161202167	591683833
% Difference	1.85%	0.20%	1.73%	0.23%
Consumer Surplus				
Base	3.17	0.87	3.30	1.65
Shocked	3.17	0.87	3.30	1.66
% Difference	0%	0.11%	0%	0.22%

Import Country	Russia	Mexico	Russia	Mexico
Import Prices	with market power		without market power	
Base	83.35	125.34	30.74	42.90
Shocked	83.51	125.63	30.77	42.99
% Difference	0.20%	0.22%	0.05%	0.04%
Net Exports				
Base	93053	94206	132827	96843
Shocked	92956	94197	132823	96840
% Difference	-0.18%	-0.06%	-0.05%	-0.04%

Export Country	EU	Brazil	EU	Brazil
Export Prices	with market power		without market power	
Base	138.19	143.91	90.05	53.32
Shocked	138.36	144.22	90.11	53.43
% Difference	0.11%	0.20%	0.01%	0.24%
Net Exports				
Base	131932	219281	74390	134837
Shocked	132049	219471	74369	134826
% Difference	0.08%	0.13%	0.02%	0.05%

5.1.2 The U.S. Turkey Export Subsidy

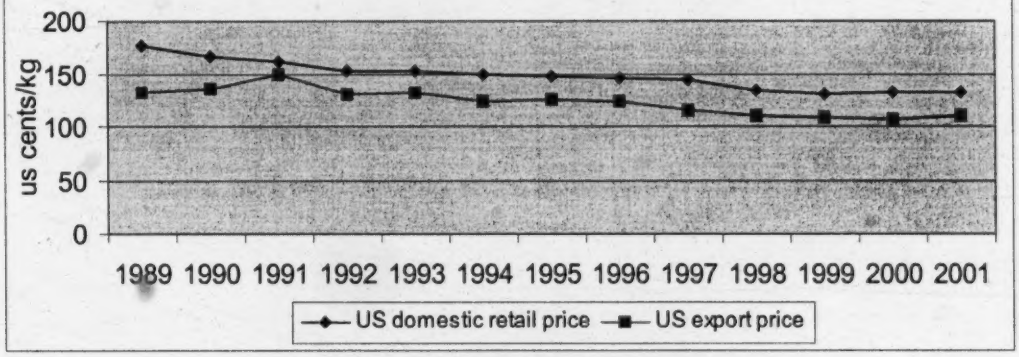
In the previous section, the impact of the chicken export subsidy from the U.S. on the world chicken market was discussed. The effect of this policy shock on the turkey market was discussed as well. In this section, the impact of the U.S. turkey export subsidy on the world turkey market is analyzed. Canada is a net turkey exporter; turkey is the main substitute good for chicken. In the current study, the data indicates that the U.S. turkey export price is lower than its domestic retail price (Table 5.3 and Figure 5.2). Thus, U.S. turkey exports are assumed to be subsidized by this value for this simulation.

5.1.2.1 Removal of the U.S. Turkey Export Subsidy – Impact on Turkey Market

The estimation results (Table 5.4-1) show that turkey export subsidies from the U.S. have similar influences on the international turkey market, as those for the

international chicken market. After the removal of the U.S. turkey export subsidies, the U.S. turkey retail price decreases by 0.87% (MP) and 2.95% (NMP), and net U.S. turkey exports decrease by 52.29% (MP) and 14.16% (NMP). Retail demand increases by 0.57% (MP) and 0.56% (NMP). This change causes total supply to decrease by 1.47% (MP) and 0.87% (NMP). These results indicate that if the U.S. subsidizes its turkey exports, U.S. turkey domestic demand could decrease and net exports could increase.

Figure 5.2 Comparison of the U.S. Turkey Export Price and Domestic Retail Price, 1989-2001



(Source: FAO Statistical Database, 2002)

Table 5.3 The U.S. Turkey Export Price and Retail Price from 1990-2001, (cents/kg)

Year	*Retail Price*	*Export Price*	*Difference*
1989	176.29	131.98	44.31
1990	166.71	135.80	30.92
1991	161.47	148.93	12.54
1992	152.42	130.89	21.54
1993	152.91	132.37	20.55
1994	148.71	123.16	25.56
1995	148.15	125.15	23.01
1996	146.17	123.54	22.64
1997	143.54	114.65	28.89
1998	134.35	110.77	23.59
1999	130.83	108.41	22.43
2000	131.86	106.39	25.47
2001	132.32	109.45	22.88

(Source: FAO Statistical Database, 2002)

In the international turkey market, after the removal of the U.S. turkey export subsidies, the EU and Brazilian export prices and quantities rise. The two main turkey importers, Mexico and Russia, decrease turkey imports due to the increase in import prices.

Similar to the chicken export subsidy, the removal of the U.S. turkey export subsidy does not affect Canada's domestic turkey retail demand and price. Processor demand and retail supply both increase. The Canadian turkey export price increases by 15.14% (MP) and 32.96% (NMP), and Canadian turkey export quantities increase by 61.84% (MP) and 54.45% (NMP). The above results suggest that the U.S. turkey export subsidy could improve U.S. turkey exports, but deteriorate turkey exports from Canada, the EU and Brazil.

Table 5.4-1 Market Simulation Results after Removal of the U.S. Turkey Export Subsidy-Impact on Turkey Market (1990-2001 Average)

International Turkey Market	**Canada**	**U.S.**	**Canada**	**U.S.**
	with market power		without market power	
Retail Price				
Base	142.07	144.70	65.58	66.64
Shocked	142.07	143.46	65.58	64.97
% Difference	0.00%	-0.87%	0.00%	-2.95%
Retail Demand				
Base	128872	2118286	133480	2882700
Shocked	128872	2130356	133480	2899082
% Difference	0.00%	0.57%	0.00%	0.56%
Processor Demand				
Base	273043	2938090	278666	4166996
Shocked	274056	2890385	279659	4126612
% Difference	0.37%	-1.56%	0.36%	-0.90%
Farm Price				
Base	N/A	27.08	N/A	54.92
Shocked	N/A	26.05	N/A	54.05
% Difference	N/A	-3.87%	N/A	-1.70%
Quota Price				
Base	8.87	N/A	8.09	N/A
Shocked	8.09	N/A	7.49	N/A

% Difference	-0.87%	N/A	-0.20%	N/A
Farm Marginal Cost				
Base	77.13	N/A	81.59	N/A
Shocked	77.91	N/A	82.35	N/A
% Difference	0.97%	N/A	0.89%	N/A
Retail Supply				
Base	136133	2287935	138973	3192647
Shocked	136646	2252862	139475	3162909
% Difference	0.38%	-1.47%	0.36%	-0.87%
Export (Import) Price				
Base	87.00	N/A	41.13	N/A
Shocked	100.11	N/A	54.00	N/A
% Difference	15.14%	N/A	32.96%	N/A
Net Trade				
Base	31402	154776	37058	338498
Shocked	45350	105338	51606	290330
% Difference	61.84%	-52.29%	54.45%	-14.16%
Producer Surplus				
Base	17562442	72639300	18539442	178854750
Shocked	17737083	69225000	18710383	174901833
% Difference	0.97%	-4.68%	0.89%	-2.27%
Processor Profits				
Base	271612667	409519083	143611750	580398000
Shocked	277116833	402846583	146205083	574748417
% Difference	2.03%	-1.56%	1.81%	-0.90%
Consumer Surplus				
Base	4.63	0.87	4.97	1.62
Shocked	4.63	0.88	4.97	1.63
% Difference	0.00%	1.15%	0.00%	1.13%

Country	**Russia**	**Mexico**	**Russia**	**Mexico**
Import Prices	with market power		without market power	
Base	83.40	125.43	31.16	43.34
Shocked	97.93	148.68	45.37	66.12
% Difference	17.30%	18.71%	50.19%	66.25%
Net Imports				
Base	93020	94204	132332	96829
Shocked	82357	93460	121930	96101
% Difference	-14.18%	-2.02%	-9.10%	-2.02%

Country	**EU**	**Brazil**	**EU**	**Brazil**
Export Prices	with market power		without market power	
Base	138.24	144.01	90.31	58.90
Shocked	151.82	169.55	103.61	84.09
% Difference	10.49%	18.34%	18.23%	85.28%

Net Exports				
Base	131973	219347	75303	136030
Shocked	147075	241772	89998	157879
% Difference	9.47%	11.08%	19.57%	21.66%

5.1.2.2 Removal of the U.S. Turkey Export Subsidy – Impact on Chicken Market

The U.S. turkey export subsidy does not noticeably impact the chicken market. The removal of the turkey export subsidy leads to a fall in the U.S. retail chicken price as well as demand under both market structures. Net exports of U.S. chicken rise by 0.05% (MP) and 0.12% (NMP). This result suggests that the export subsidy on turkey could decrease U.S. chicken exports. The other main turkey exporters, Brazil and the EU indicate decreasing net exports of chicken after the removal of the turkey export subsidies, while in Japan, China and Russia imports of chicken increase. Therefore, one can draw the conclusion that the U.S. turkey export subsidy could improve its turkey exports, but not exports of chicken.

The U.S. turkey export subsidy does not impact Canadian retail demand and price due to supply management and import quotas. However, Canada's chicken export price decreases by 0.05% (MP) and 0.21% (NMP). Canada's net exports drop by 0.23% (MP) and 0.24% (NMP). Therefore, one can draw the conclusion that the U.S. turkey export subsidy could improve the chicken exports of its competitors.

Table 5.4-2 Market Simulation Results after Removal of the U.S. Turkey Export Subsidy –Impact on Chicken Market (1990-2001 Average)

International Chicken Market	Canada	U.S.	EU	Canada	U.S.	EU
	(with market power)			(without market power)		
Retail Price						
Base	190.07	140.82	174.61	87.81	88.32	82.50
Shocked	190.07	140.68	174.61	87.81	87.90	82.52
% Difference	0.000%	-0.097%	0.003%	0.000%	-0.460%	0.040%

Retail Demand						
Base	717574	9597106	7166956	768828	9598729	8668546
Shocked	717574	9589824	7166867	768828	9571948	8668101
% Difference	0.000%	-0.073%	-0.001%	0.000%	-0.272%	-0.005%
Processor Demand						
Base	1876828	15480775	9830326	1981500	15791325	11763964
Shocked	1876735	15471550	9829936	1981215	15756650	11762549
% Difference	-0.005%	-0.055%	-0.004%	-0.014%	-0.204%	-0.011%
Farm Price						
Base	N/A	26.22	50.74	N/A	27.30	79.82
Shocked	N/A	26.16	50.73	N/A	27.07	79.80
% Difference	N/A	-0.226%	-0.013%	N/A	-0.979%	-0.030%
Farm Marginal Cost						
Base	54.60	N/A	N/A	57.76	N/A	N/A
Shocked	54.60	N/A	N/A	57.75	N/A	N/A
% Difference	-0.005%	N/A	N/A	-0.014%	N/A	N/A
Farm Quota Price						
Base	12.64	N/A	N/A	9.48	N/A	N/A
Shocked	12.64	N/A	N/A	9.49	N/A	N/A
% Difference	0.034%	N/A	N/A	0.914%	N/A	N/A
Retail Supply						
Base	705753	11289808	7642155	749380	11488342	9379559
Shocked	705714	11282139	7641800	749261	11458332	9378292
% Difference	-0.005%	-0.064%	-0.004%	-0.015%	-0.244%	-0.013%
Export (Import) Price						
Base	104.75	N/A	120.92	82.91	N/A	95.15
Shocked	104.70	N/A	120.85	82.74	N/A	94.95
% Difference	-0.056%	N/A	-0.060%	-0.215%	N/A	-0.235%
Net Trade						
Base	31319	1545014	427469	18495	1777629	416237
Shocked	31284	1545791	427253	18389	1779981	415566
% Difference	-0.233%	0.055%	-0.049%	-0.242%	0.127%	-0.150%
Producer Surplus						
Base	6.02E+07	2.14E+08	4.69E+08	6.34E+07	2.21E+08	8.08E+08
Shocked	6.02E+07	2.13E+08	4.69E+08	6.34E+07	2.19E+08	8.08E+08
% Difference	-0.005%	-0.277%	-0.015%	-0.014%	-1.168%	-0.037%
Processor Profits						
Base	3.56E+08	2.41E+09	1.76E+09	6.67E+07	1.19E+09	8.06E+08
Shocked	3.56E+08	2.40E+09	1.76E+09	6.67E+07	1.18E+09	8.06E+08
% Difference	-0.006%	-0.142%	-0.004%	-0.033%	-0.651%	-0.003%
Consumer Surplus						
Base	9.21	15.76	4.43	11.17	16.68	6.50
Shocked	9.21	15.75	4.43	11.17	16.64	6.50
% Difference	0.000%	-0.058%	-0.002%	0.000%	-0.227%	-0.009%

Country	Japan	China	Russia	Japan	China	Russia
	with market power			without market power		
Import Prices						
Base	200.04	93.66	124.69	123.83	88.22	123.43
Shocked	199.85	93.65	124.68	123.25	88.19	123.42
% Difference	-0.100%	-0.013%	-0.003%	-0.509%	-0.039%	-0.011%
Net Imports						
Base	527679	341123	496074	582139	399803	507385
Shocked	527679	341255	496106	582557	400169	507482
% Difference	0.025%	0.045%	0.008%	0.067%	0.095%	0.024%

Country	Brazil	Brazil
Export Prices	with market power	without market power
Base	119.57	103.06
Shocked	119.53	102.94
% Difference	-0.034%	-0.120%
Net Exports		
Base	567829	483859
Shocked	567604	483165
% Difference	-0.038%	-0.133%

5.1.3 The U.S. Chicken and Turkey Export Subsidy Impact on Consumer Surplus, Processor Profits and Producer Surplus

One of the objectives of this study is to analyze the consumer, processor and producer welfare changes due to government policies. Table 5.2-1 provides such information for the chicken market. Under both market structures, the removal of the U.S. chicken export subsidy could decrease both U.S. producer surplus (9.15% and 6.70%) and processor profits (5.78% and 6.35%), whereas, the U.S. consumer welfare increases by 0.76% (MP) and 1.79% (NMP). From these results, one can draw the conclusion that the export subsidy from the U.S. benefits its producers and processors but not the consumers. Canadian consumer welfare does not change. As compared with the U.S., Canadian producer surplus increases by 1.97% (MP) and1.69% (NMP) due to the increased farm marginal cost and processor demand. Processor profits increase by 2.62% (MP) and 2.69% (NMP) after the removal of the U.S. export subsidies. Therefore, one

can draw the conclusion that because of the supply management program, the U.S. chicken export subsidy does not affect Canadian consumer welfare. However, they have negative impacts on Canadian producers and processors. For the EU, both processor and producer welfares increase under both market structures. As opposed to Canada, EU consumer surplus decreases by 0.58% (MP) and 0.57% (NMP).

The removal of the U.S. chicken export subsidy could also affect the turkey consumer, processor and producer welfare as shown in Table 5.2-2. Both Canadian and U.S. turkey producer and processor welfare increase after the removal of the chicken export subsidy. U.S. consumer surplus increases, as well.

Table 5.4-1 provides the welfare simulation results for the turkey market. After the removal of the U.S. turkey export subsidy, the U.S. producer surplus and processor profits both increase by 0.97% and 0.89% under the oligopoly market, and decrease by 2.03% and 1.81% under the assumption of a perfectly competitive market. Without the turkey export subsidy, Canadian consumer surplus does not change, but both Canadian turkey producer surplus and processor profits increase.

Table 5.4-2 presents the market welfare simulation results for chicken after the removal of the U.S. turkey export subsidy. All of the Canadian, U.S. and EU turkey producer and processor surpluses decrease. Consumer welfare for the U.S. and EU decrease as well.

5.2 Canadian Export Policy Removal Simulation Results

As introduced in the previous sections, Canada's poultry exports mainly rely on its chicken (turkey) export policies. In this section, simulation is conducted based on

these two policies. Prior to 1994, Canada had few poultry exports. In 1994, the Canadian Turkey Agency and Chicken Farmers of Canada published the "Turkey Export Policy" and "Marketing Development Program", respectively. Since then, Canada has successfully expanded its poultry exports. In order to simulate this shock, the export amounts of both chicken and turkey after 1992 are reduced to zero, because without these policies, Canadian poultry producers would not be allowed to export. To some extent, Canada's poultry export policies are similar to the dairy one.

In 1999, a WTO panel and the Appellate Body found that Canada's special milk class system, which provided discounted milk for export, was indeed an export subsidy. The Panel claimed that dairy processors in Canada were provided with milk for export at a lower price than the regulated domestic price. In July 2002, the panel concluded that Canada continued to provide illegal export subsidies to Canadian dairy processors with the sale of discounted milk under the CEM program. The Appellate Body of the WTO affirmed the panel's findings in December 2002.

Therefore, it is necessary to examine the impacts of the Canadian poultry export policies on the domestic and international markets. Poultry producer and processor surplus changes caused by the policy effect need to be examined as well.

5.2.1 Canadian Chicken Export Policy

The Canadian chicken export policy (Marketing Development Program) has a noticeable effect on both the domestic and international poultry market. In the current study, the model with the export policies is chosen as the base model. The model without

the export policy is chosen for the shocked model, in which Canada's total chicken and turkey exports are assumed to remain at zero after 1994.

5.2.1.1 Removal of the Chicken Export Policy -- Impact on Chicken Market

The influences of Canadian chicken export policies on all chicken industries are presented in Table 5.5-1. In Canada, without the chicken export policy, neither the chicken retail price nor retail demand change due to the supply management program. Both processor demand and retail supply decrease by 3.75% and 4.13%. In the assumed perfectly competitive model, the two variables drop by 3.33% and 3.62%, which are slightly less than in the oligopoly model. The farm quota value increases under both market structures and farm marginal costs decrease because of the unchanged farm price.

In the international chicken market, the removal of the Canadian chicken export policies has significant effects on the main exporters. In the U.S. chicken market, the retail price of chicken increases by 0.19% (MP) and 0.29% (NMP), and retail demand declines by 0.05% (MP) and 0.05% (NMP). In addition, U.S. chicken exports increase under both market structures. Similar to the U.S., the EU and Brazilian export price and quantities increase due to the removal of the Canadian export policy.

Under an oligopoly market, the three main chicken importers (Russia, Japan and China) decrease their chicken imports by 0.05%, 0.06% and 0.01%, respectively since they can not get more competitive prices. Under the assumed perfectly competitive market these values are 0.05%, 0.05% and 0.01%. The results show that these main chicken importers could decrease net imports without the Canadian chicken export policy.

The simulation results suggest that Canadian chicken export policy could increase the import quantities of the main chicken importers. However, the main chicken exporters like the U.S., EU, and Brazil might lose some of their export market shares.

Table 5.5-1 Market Simulation Results after Removal of the Canadian Chicken Export Policy - Impact on Chicken Market (1990-2001 Average)

International Chicken Market	Canada	U.S.	EU	Canada	U.S.	EU
	(with market power)			(without market power)		
Retail Price						
Base	193.41	141.26	174.85	90.97	95.31	82.42
Shocked	193.41	141.53	174.86	90.97	95.59	82.43
% Difference	0.00%	0.19%	0.004%	0.00%	0.29%	0.01%
Retail Demand						
Base	743021	9595445	7172338	848847	10425386	8681169
Shocked	743021	9590711	7172249	848847	10420367	8681050
% Difference	0.00%	-0.05%	-0.001%	0.00%	-0.05%	-0.001%
Processor Demand						
Base	1944407	15484150	9825212	2232098	16892350	11778167
Shocked	1864244	15516717	9825623	2151935	16924342	11778567
% Difference	-3.75%	0.19%	0.004%	-3.33%	0.17%	0.003%
Farm Price						
Base	N/A	39.37	50.45	N/A	44.55	79.74
Shocked	N/A	39.50	50.45	N/A	44.66	79.75
% Difference	N/A	0.31%	0.01%	N/A	0.30%	0.01%
Farm Quota Value						
Base	10.71	N/A	N/A	1.89	N/A	N/A
Shocked	13.10	N/A	N/A	4.27	N/A	N/A
% Difference	57.84%	N/A	N/A	55.73%	N/A	N/A
Farm Marginal Cost						
Base	56.53	N/A	N/A	65.35	N/A	N/A
Shocked	54.15	N/A	N/A	62.97	N/A	N/A
% Difference	-4.37%	N/A	N/A	-3.92%	N/A	N/A
Retail Supply						
Base	734161	11296694	7635086	854911	12381406	9389577
Shocked	700459	11324428	7635468	821209	12408548	9389924
% Difference	-4.13%	0.22%	0.005%	-3.62%	0.20%	0.004%
Export (Import) Price						
Base	104.94	N/A	121.14	85.82	N/A	98.58
Shocked	105.05	N/A	121.27	85.94	N/A	98.72
% Difference	0.11%	N/A	0.12%	0.15%	N/A	0.16%

Net Trade						
Base	N/A	1542391	427730	N/A	1726362	426372
Shocked	N/A	1571014	428152	N/A	1754892	426821
% Difference	N/A	1.45%	0.09%	N/A	1.32%	0.10%
Producer Surplus						
Base	6.31E+07	2.19E+08	4.66E+08	7.22E+07	2.90E+08	8.07E+08
Shocked	6.02E+07	2.21E+08	4.66E+08	6.93E+07	2.93E+08	8.08E+08
% Difference	-4.37%	1.08%	0.02%	-3.92%	0.96%	0.01%
Processor Profits						
Base	3.75E+08	2.41E+09	1.76E+09	2.05E+08	1.79E+09	9.83E+08
Shocked	3.60E+08	2.43E+09	1.76E+09	1.98E+08	1.80E+09	9.83E+08
% Difference	-3.70%	0.51%	0.01%	-3.26%	0.58%	0.03%
Consumer Surplus						
Base	6.7544	15.7581	4.4241	9.1438	18.0220	6.5002
Shocked	6.7544	4.4240	4.4240	9.1438	18.0072	6.5000
% Difference	0.00%	-0.08%	-0.003%	0.00%	-0.08%	-0.090%

Import Country	**Japan**	**China**	**Russia**	**Japan**	**China**	**Russia**
	with market power			without market power		
Import Prices						
Base	201.10	93.71	124.69	134.48	88.91	123.60
Shocked	201.48	93.73	124.70	134.88	88.93	123.61
% Difference	0.19%	0.02%	0.01%	0.31%	0.03%	0.01%
Net Imports						
Base	526782	340598	496008	574512	392337	505885
Shocked	526510	340371	495945	574223	392096	505817
% Difference	-0.05%	-0.06%	-0.01%	-0.05%	-0.05%	-0.01%

Export Country	**Brazil**	**Brazil**
Export Prices	with market power	without market power
Base	119.87	105.43
Shocked	119.96	105.52
% Difference	0.07%	0.08%
Net Exports		
Base	569326	496059
Shocked	569801	496565
% Difference	0.08%	0.09%

5.2.1.2 Removal of the Chicken Export Policy -- Impact on Turkey Market

Canada's chicken export policy could affect the international turkey market. Table 5.5-2 presents the simulation results. The removal of the Canadian chicken export

policy increases U.S. net exports by 0.03% (MP) and 0.006% (NMP) and decreases the U.S. turkey retail price by only 0.013% (MP) and 0.002% (NMP). The EU and Brazil reduce their net exports after the removal of the Canadian chicken export policy. Russia and Mexico increase their imports.

For the Canadian turkey market, the turkey retail price and retail demand are not affected by the policy change due to the supply management program. However, the turkey export price decreases by 0.012% (MP) and 0.0024% (NMP). Processor demand decreases under both market structures, as do turkey exports. These results suggest that the Canadian chicken export policy could also help its turkey processors to expand their exports.

Therefore, one can conclude that the Canadian chicken export policy improves not only its chicken exports, but also the turkey exports. However, the policy causes decreased exports of other main turkey exporters.

Table 5.5-2 Market Simulation Results after Removal of the Canadian Chicken Export Policy – Impact on Turkey Market (1990-2001 Average)

International Turkey Market	**Canada**	**U.S.**	**Canada**	**U.S.**
	With market power		without market power	
Retail Price				
Base	143.44	144.48	80.36	66.28
Shocked	143.44	144.46	80.36	66.27
% Difference	0%	-0.0136%	0%	-0.0015%
Retail Demand				
Base	129302	2115993	128706	2936877
Shocked	129302	2115427	128706	2936592
% Difference	0%	-0.0268%	0%	-0.0095%
Processor Demand				
Base	273830	2937600	268949	4243539
Shocked	273829	2936914	268949	4243162
% Difference	-0.0003%	-0.0222%	0.0000%	-0.0083%
Farm Price				
Base	N/A	26.92	N/A	56.37

Shocked	N/A	26.90	N/A	56.36
% Difference	N/A	-0.0554%	N/A	-0.0149%
Farm Marginal Cost				
Base	78.03	N/A	74.47	N/A
Shocked	78.03	N/A	74.47	N/A
% Difference	-0.0009%	N/A	-0.0001%	N/A
Quota Value				
Base	7.97	N/A	11.54	N/A
Shocked	7.97	N/A	11.54	N/A
% Difference	0.0083%	N/A	0.0041%	N/A
Retail Supply				
Base	136530	2287571	134061	3250095
Shocked	136529	2287066	134061	3249817
% Difference	-0.0003%	-0.0210%	-0.00003%	-0.0080%
Export (Import) Price				
Base	86.87	N/A	41.00	N/A
Shocked	86.86	N/A	40.99	N/A
% Difference	-0.0128%	N/A	-0.0024%	N/A
Net Trade				
Base	10706	155274	8903	341059
Shocked	10705	155328	8902	341059
% Difference	-0.0041%	0.0289%	-0.0004%	0.0006%
Producer Surplus				
Base	1.77E+07	7.20E+07	1.68E+07	1.85E+08
Shocked	1.77E+07	7.20E+07	1.68E+07	1.85E+08
% Difference	-0.0009%	-0.0677%	-0.0001%	-0.0204%
Processor Profits				
Base	2.66E+08	4.09E+08	1.61E+08	5.91E+08
Shocked	2.55E+08	4.09E+08	1.55E+08	5.91E+08
% Difference	-3.8837%	-0.0222%	-3.6417%	-0.0083%
Consumer Surplus				
Base	3.17	0.88	3.30	1.66
Shocked	3.17	0.88	3.30	1.65
% Difference	0.0000%	-0.0179%	-0.0090%	-0.0090%

Import Country	**Russia**	**Mexico**	**Russia**	**Mexico**
Import Prices	with market power		without market power	
Base	83.25	125.20	30.77	42.95
Shocked	83.24	125.18	30.76	42.95
% Difference	-0.0155%	-0.0167%	-0.0010%	0.0000%
Net Imports				
Base	93133	94211	132811	96842
Shocked	93144	94212	132811	96842
% Difference	0.0104%	0.0006%	0.0010%	0.0001%

Export Country	EU	Brazil	EU	Brazil
Export Prices	with market power		without market power	
Base	138.11	143.76	90.09	53.10
Shocked	138.10	143.74	90.09	53.09
% Difference	-0.0099%	-0.0165%	-0.0004%	-0.0058%
Net Exports				
Base	131819	219128	67130	134867
Shocked	131801	219104	67129	134867
% Difference	-0.0100%	-0.0110%	-0.0009%	-0.0013%

5.2.2 Canadian Turkey Export Policy

As introduced in Chapter 2, Canada is a net turkey exporter. The Canadian Turkey Export Policy published by the Canadian Turkey Agency plays a significant role in its export sector. Contrary to the chicken export policy, turkey exports can be generated as production credits. The policy states that "to maintain domestic supply requirements, any province which has exported young turkey grown within quota, will be eligible to apply for export credits; where production of young turkey is required over and above a province's allocation for the purposed of an export market, a conditional permit may be issued by the CTMA to the provincial Commodity Board, in order to maintain domestic supply requirements." In other words, Canadian turkey producer production for the purpose of export could be generated as one part of the production quotas. Their production quotas for domestic market supply are combined with their exports. This indicates that production after the exports may not increase as much as for the chicken market and turkey production would have been lower without the exports. Therefore, in the current study, policy simulation is conducted under two possible scenarios for the Canadian domestic turkey industry. In the first scenario, turkey exports are considered as production credits. In the second scenario, turkey exports are not

considered as production credits. Under each scenario, the impacts of the turkey export policy on the international trade market are the same. The differences are only within the Canadian domestic turkey industry.

5.2.2.1 Removal of the Turkey Export Policy -- Impact on Turkey Market

The results in Table 5.6-1 suggest that the Canadian turkey export policy impacts the world turkey trade market significantly. After the removal of this policy, the U.S. turkey retail price rises by 0.15% (MP) and 0.51% (NMP); U.S. retail demand decreases by 0.10% under both market structures; and processor demand increases by 0.29% (MP) and 0.17% (NMP). Brazil's export price level increases by 0.18% (MP) and 1.01% (NMP). Brazil could increase its turkey export quantity because of the lower export price level. Furthermore, the EU export price increases by 0.11% (MP) and 0.27% (NMP), and net exports increase by 0.10% (MP) and 0.10% (NMP). The two main turkey importers, Russia and Mexico, both reduce their turkey imports. The above results suggest that Canadian turkey export policy leads to a decrease in the export market shares of its competitors like the U.S., EU and Brazil.

The elimination of the Canadian poultry export policy does not change the retail price and retail demand of Canadian domestic turkey markets due to the supply management. However, it changes processor demand, farm marginal cost, the quota value, retail supply, and export prices. If exports are considered as part of the production credits, processor demand falls by 0.33% (MP) and 0.34% (NMP). If exports are not considered as production credits, the processor demand is reduced by 6.75% (MP) and

6.56% (NMP). The above results suggest that the Canadian turkey export policy could increase total production in its domestic market.

Table 5.6-1 Market Simulation Results after Removal of the Canadian Turkey Export Policy – Impact on Turkey Market (1990-2001 Average)

International Turkey Market	Canada (no credit concern)	Canada (consider credits)	U.S.	Canada (no credit concern)	Canada (consider credits)	U.S.
	with market power			without market power		
Retail Price						
Base	142.07	142.07	144.69	65.58	65.58	66.58
Shocked	142.07	142.07	144.91	65.58	65.58	66.88
% Difference	0%	0%	0.15%	0%	0%	0.51%
Retail Demand						
Base	128895	128895	2116727	133503	133503	2881185
Shocked	128895	128895	2114586	133503	133503	2878292
% Difference	0%	0%	-0.10%	0%	0%	-0.10%
Processor Demand						
Base	273782	273782	2937729	283017	283017	4165265
Shocked	254732	272550	2946514	263966	281785	4172769
% Difference	-6.75%	-0.33%	0.29%	-6.56%	-0.34%	0.17%
Farm Price						
Base	N/A	N/A	27.08	N/A	N/A	54.88
Shocked	N/A	N/A	27.26	N/A	N/A	55.04
% Difference	N/A	N/A	0.69%	N/A	N/A	0.30%
Farm Marginal Cost						
Base	77.56	77.56	N/A	84.77	84.77	N/A
Shocked	63.23	76.92	N/A	70.43	84.12	N/A
% Difference	-17.78%	-0.79%	N/A	-16.96%	-1.26%	N/A
Quota Value						
Base	8.44	8.44	N/A	1.24	2.71	N/A
Shocked	22.78	9.09	N/A	15.58	4.81	N/A
% Difference	169.85%	57.20%	N/A	115.91%	77.53%	N/A
Retail Supply						
Base	136510	136510	2287670	141175	141175	3191373
Shocked	126875	135884	2294130	131539	140548	3196899
% Difference	-6.84%	-0.33%	0.27%	-6.65%	-0.34%	0.16%
Export (Import) Price						
Base	87.00	87.00	N/A	41.10	41.10	N/A
Shocked	87.13	87.13	N/A	41.27	41.27	N/A
% Difference	0.15%	0.15%	N/A	0.46%	0.46%	N/A
Net Trade						
Base	N/A	N/A	154458	N/A	N/A	336519
Shocked	N/A	N/A	163449	N/A	N/A	345314
% Difference	N/A	N/A	6.73%	N/A	N/A	2.55%
Producer Surplus						
Base	1.77E+07	1.77E+07	7.26E+07	1.93E+07	1.93E+07	1.79E+08
Shocked	1.44E+07	1.75E+07	7.32E+07	1.60E+07	1.91E+07	1.79E+08
% Difference	-17.78%	-0.79%	0.85%	-16.96%	-1.26%	0.41%

Processor Profits						
Base	2.72E+08	1.46E+08	4.09E+08	1.46E+08	1.46E+08	5.80E+08
Shocked	2.62E+08	1.41E+08	4.11E+08	1.41E+08	1.41E+08	5.81E+08
% Difference	-3.73%	-3.31%	0.29%	-3.31%	-3.31%	0.17%
Consumer Surplus						
Base	4.63	4.63	0.87	4.97	4.97	1.62
Shocked	4.63	4.63	0.87	4.97	4.97	1.61
% Difference	0%	0%	-0.20%	0%	0%	-0.20%

Country	**Russia**	**Mexico**	**Russia**	**Mexico**
Import Prices	with market power		without market power	
Base	83.40	125.43	31.11	43.27
Shocked	83.54	125.66	31.31	43.59
% Difference	0.17%	0.19%	0.72%	0.95%
Net Imports				
Base	93031	94204	132372	96831
Shocked	92920	94196	132220	96821
% Difference	-0.14%	-0.01%	-0.12%	-0.01%

Country	**EU**	**Brazil**	**EU**	**Brazil**
Export Prices	with market power		without market power	
Base	138.24	144.00	90.27	53.93
Shocked	138.38	144.26	90.46	54.25
% Difference	0.11%	0.18%	0.27%	1.01%
Net Exports				
Base	131954	219323	131954	135944
Shocked	132112	219556	132112	136266
% Difference	0.10%	0.11%	0.10%	0.31%

5.2.2.2 Removal of the Turkey Export Policy -- Impact on Chicken Market

Canada's turkey export policy could affect the chicken market as well. Table 5.6-2 provides the relevant information. Under both market structures, the removal of the Canadian turkey export policy increases the U.S. chicken retail price and demand. It also lowers U.S. net exports of chicken. The removal of the Canadian turkey export policy increases the EU chicken retail price and demand slightly. Net exports of the EU could go up by 0.027% (MP) and 0.11% (NMP). The above simulation results suggest that the "Canadian Turkey Export Policy" could increase U.S. chicken exports, but reduce EU chicken exports. For the other countries, net Brazilian chicken exports rise after removal

of the Canadian turkey export policy, and Russia, Japan and China lower their imports. For Canada, both chicken retail prices remain unchanged. The Canadian chicken export price increases by 0.036% and 0.033% under an oligopoly and perfectly competitive market structure, respectively. Therefore, one can conclude that the Canadian turkey export policy improves its turkey exports but not exports of chicken.

Table 5.6-2 Market Simulation Results after Removal of the Canadian Turkey Export Policy –Impact on Chicken Market (1990-2001 Average)

International Chicken Market	Canada	U.S.	EU	Canada	U.S.	EU
	(with market power)			(without market power)		
Retail Price						
Base	190.07	87.03	174.87	87.81	88.30	82.26
Shocked	190.07	87.10	174.87	87.81	88.36	82.27
% Difference	0.0000%	0.0826%	0.0012%	0.0000%	0.0763%	0.0027%
Retail Demand						
Base	717701	9669714	7172160	848847	9590470	8683698
Shocked	717701	9674842	7172161	768964	9595204	8683699
% Difference	0.0000%	0.0525%	0.0001%	0.0000%	0.0484%	0.0001%
Processor Demand						
Base	1876821	15478033	9824345	1981491	15789750	11768502
Shocked	1864244	15483950	9824456	1981532	15795942	11768585
% Difference	0.0029%	0.0355%	0.0011%	0.0022%	0.0372%	0.0007%
Farm Price						
Base	N/A	26.22	50.46	N/A	27.29	79.63
Shocked	N/A	26.25	50.46	N/A	27.33	95.17
% Difference	N/A	0.1253%	0.0042%	N/A	0.1369%	0.0020%
Farm Quota Value						
Base	12.64	N/A	N/A	9.48	N/A	N/A
Shocked	12.64	N/A	N/A	9.48	N/A	N/A
% Difference	-0.0139%	N/A	N/A	-0.1236%	N/A	N/A
Farm Marginal Cost						
Base	54.60	N/A	N/A	57.76	N/A	N/A
Shocked	54.60	N/A	N/A	57.76	N/A	N/A
% Difference	0.0031%	N/A	N/A	0.0023%	N/A	N/A
Retail Supply						
Base	762840	11287944	7634723	749376	11487150	9381294
Shocked	762859	11292744	7634837	749393	11492192	9381356
% Difference	0.0026%	0.0400%	0.0015%	0.0024%	0.0423%	0.0007%
Export (Import) Price						
Base	81.18	N/A	120.92	82.90	N/A	95.14

Shocked	81.21	N/A	120.96	82.93	N/A	95.17
% Difference	0.0362%	N/A	0.0357%	0.0334%	N/A	0.0365%
Net Trade						
Base	20639	1545250	427261	18492	1777571	416366
Shocked	20639	1544791	427385	18508	1777219	416458
% Difference	0.0362%	-0.0304%	0.0275%	0.1193%	-0.0214%	0.1193%
Producer Surplus						
Base	6.02E+07	2.14E+08	4.66E+08	6.34E+07	2.21E+08	8.06E+08
Shocked	6.02E+07	2.14E+08	4.66E+08	6.34E+07	2.22E+08	8.06E+08
% Difference	0.0031%	0.1589%	0.0048%	0.0023%	0.1720%	0.0024%
Processor Profits						
Base	3.56E+08	2.41E+09	1.76E+09	1.74E+08	1.57E+09	9.78E+08
Shocked	3.56E+08	2.41E+09	1.76E+09	1.74E+08	1.57E+09	9.78E+08
% Difference	0.0039%	0.0882%	0.0042%	0.0033%	0.1075%	0.0058%
Consumer Surplus						
Base	9.21	15.75	4.42	11.17	16.68	6.50
Shocked	9.21	15.76	4.42	11.17	16.68	6.50
% Difference	0.0%	0.0374%	-0.0008%	0.0%	0.0415%	-0.0006%

Import Country	**Japan**	**China**	**Russia**	**Japan**	**China**	**Russia**
	with market power			without market power		
Import Prices						
Base	199.99	93.66	124.69	123.80	88.22	123.43
Shocked	200.11	93.67	124.69	123.90	88.22	123.43
% Difference	0.0588%	0.0075%	0.0227%	0.0759%	0.0064%	0.0209%
Net Imports						
Base	527575	341114	496077	582159	399818	507388
Shocked	527491	341039	496058	582093	399756	507374
% Difference	-0.015%	-0.022%	-0.006%	-0.010%	-0.016%	-0.005%

Export Country	**Brazil**	**Brazil**
	with market power	without market power
Export Prices		
Base	119.57	103.06
Shocked	119.59	103.08
% Difference	0.0208%	0.0186%
Net Exports		
Base	567831	483828
Shocked	567968	483930
% Difference	0.0227%	0.0209%

5.2.3. The Canadian Poultry Export Policy Impact on Consumer Surplus, Processor Profits and Producer Surplus

There is a noticeable decrease in Canadian poultry producer surplus and processor profits due to the removal of the Canadian chicken export policies (see results in Table 5.5-1). In Canada, the removal of the chicken export policy causes Canadian chicken producer surplus to drop by 4.37% (MP) and 3.92% (NMP), and processor profits to drop by 3.70% (MP) and 3.26% (NMP), respectively. Canadian consumer surplus does not change under all scenarios. Without the chicken export policy from Canada, U.S. producer surplus increases by 1.08% (MP) and 0.96% (NMP), and U.S. consumer welfare decreases by 0.08% under both market structures. Furthermore, U.S. processor profits increase by 0.51% (MP) and 0.58% (NMP). For the EU market, producer surplus increases by 0.02% (MP) and 0.01% (NMP), and processor profits increase by 0.01% (MP) and 0.03% (NMP). EU consumer surplus decreases by 0.003% (MP) and 0.090% (NMP). These results suggest that Canadian chicken export policy could improve its processor and producer welfare, but consumer welfare does not change. The Canadian chicken export policy could deteriorate the U.S. and EU chicken producer and processor benefits.

The removal of the Canadian chicken export policy impacts the turkey market (Table 5.5-2). Without the chicken export policy from Canada, both the U.S. and EU turkey producer surplus, processor profits, and consumer surplus decrease. In Canada, while consumer welfare remains the same, all other welfare changes are negative. This result indicates that the Canadian chicken export policy could benefit turkey producers and processors in all three countries.

The removal of the Canadian turkey export policy does not affect Canadian consumer surplus since turkey production for export purposes is combined with domestic production quotas by the marketing board. The removal of the policy causes the Canadian turkey producer surplus to drop by 0.79% (MP) and 1.26% (NMP), and processor profits to drop by 6.53% (MP) and 6.37% (NMP), respectively. These changes could be much higher if exports are not considered to be production credits by the turkey marketing board (Table 5.6-1). Without the turkey export policy from Canada, U.S. turkey producer surplus increases by 0.85% (MP) and 0.41% (NMP), U.S. consumer welfare decreases by 0.20% (MP) and 0.20% (NMP), and U.S. processor profit increases by 0.29% (MP) and 0.17% (NMP).

The removal of the Canadian turkey export policy impacts the chicken market (Table 5.6-2). Without the turkey export policy from Canada, both the U.S. and EU chicken producer surplus and processor profits increase. In Canada, while consumer welfare remains the same, all other welfare changes are positive. This result indicates that the Canadian turkey export policy could deteriorate the welfare of chicken producers and processors in all three countries.

The above discussion suggests that Canada's poultry export policy has similar consequences as the U.S. export subsidies. With this policy, the Canadian poultry producers and processors can be better off because they can get more of the international market. However, supply management keeps consumer surplus unchanged.

5.3 The EU Export Subsidy Removal Simulation Results

As discussed above, the EU is subsidizing their chicken exports to the international market. Since the EU is the second largest poultry exporter in the world, the export policy could affect the world market significantly. The following tables show the simulation results of the removal of EU chicken export subsidies on the international chicken market.

Table 5.7 The EU Chicken Export Subsidies from 1991-2001

	Outlays (MIO ECU)	*Quantity (000t)*	*Export Subsidy (EU cents/kg)*
1991	123	489	25.15
1992	130	470	27.66
1993	148	538	27.51
1994	155	565	27.43
1995	135	490	27.55
1996	115	418	27.51
1997	73	401	18.20
1998	76	393	19.34
1999	89	343	25.95
2000	75	318	23.58
2001	56	260	21.54

(Source: OECD, DSI Database, 2002)

5.3.1. The EU Chicken Export Subsidy

Table 5.8-1 demonstrates the effects of the EU export subsidies on the major chicken exporters (Canada, U.S., and Brazil) and importers (Russia, China and Japan). After removing the export subsidies from the EU, the EU chicken retail price decreases by 1.52% (MP) and 2.89% (NMP), and retail demand increases by 0.66% (MP) and 0.58% (NMP). The removal of the export policy affects the other endogenous variables as well: processor demand (-1.60% and -1.07%), farm price (-4.57% and -2.34%), and

retail supply (-1.86% and -1.18%). EU net exports show a big decrease of 13.69% (MP) and 11.81% (NMP).

After the removal of the EU chicken export subsidies, U.S. net exports increase by 7.91% (MP) and 7.94% (NMP). Brazil's net exports increase by 0.38% (MP) and 0.42% (NMP). The three main chicken importers (Russia, Japan and China) decrease import volumes by 0.47%, 0.09% and 0.54% under an oligopoly market, and by 0.35%, 0.08% and 0.41% under the assumed perfectly competitive market.

The export subsidy from the EU does not affect Canada's domestic chicken market significantly. Due to the supply management program, Canada's retail price and retail demand remain the same. The simulation results suggest that without the EU export subsidy, the chicken export price of Canada increases by 0.87% (MP) and 1.21% (NMP). Thus, Canadian chicken exports increase by 4.30% (MP) and 2.71% (NMP).

The above results clearly show that the existence of the EU chicken export subsidies decreases its competitors' total export volumes. The low EU export price could expand Japan, China and Russia's imports from the EU. As a result, the EU gets more export market share in the international chicken market.

Table 5.8-1 Market Simulation Results after Removal of the EU Chicken Export Subsidy – Impact on Chicken Market (1990-2001 Average)

International Chicken Market	**Canada**	**U.S.**	**EU**	**Canada**	**U.S.**	**EU**
	with market power			without market power		
Retail Price						
Base	193.41	147.04	188.83	90.97	95.27	108.05
Shocked	193.41	148.48	186.01	90.97	96.64	105.13
% Difference	0.00%	0.98%	-1.52%	0.00%	1.45%	-2.89%
Retail Demand						
Base	743021	9484810	6944245	848847	10414997	8262795
Shocked	743021	9458401	6990268	848847	10389815	8310484
% Difference	0.00%	-0.28%	0.66%	0.00%	-0.25%	0.58%

Processor Demand						
Base	1952027	16425958	10743721	2184796	17213017	13005967
Shocked	1953523	16639033	10566739	2186221	17395775	12861376
% Difference	0.08%	1.25%	-1.60%	0.07%	1.03%	-1.07%
Farm Price						
Base	N/A	31.54	63.90	N/A	33.58	99.09
Shocked	N/A	32.77	61.18	N/A	34.63	96.88
% Difference	N/A	3.98%	-4.57%	N/A	3.62%	-2.34%
Farm Marginal Cost						
Base	56.81	N/A	N/A	63.98	N/A	N/A
Shocked	56.86	N/A	N/A	64.02	N/A	N/A
% Difference	0.08%	N/A	N/A	0.06%	N/A	N/A
Farm Quota Price						
Base	10.43	N/A	N/A	3.26	N/A	N/A
Shocked	10.38	N/A	N/A	3.22	N/A	N/A
% Difference	-1.02%	N/A	N/A	-10.94%	N/A	N/A
Retail Supply						
Base	737329	12023772	8465548	834987	12528614	10491795
Shocked	737957	12194511	8303384	835586	12678250	10363566
% Difference	0.09%	1.37%	-1.86%	0.07%	1.16%	-1.18%
Export (Import) Price						
Base	109.26	N/A	N/A	74.93	N/A	N/A
Shocked	110.22	N/A	N/A	75.84	N/A	N/A
% Difference	0.87%	N/A	N/A	1.21%	N/A	N/A
Net Trade						
Base	33915	2334813	1364664	41845	1957848	1789369
Shocked	34466	2515925	1182018	42346	2115731	1630011
% Difference	4.30%	7.91%	-13.69%	2.71%	7.94%	-11.81%
Producer Surplus						
Base	6.34E+07	2.69E+08	6.19E+08	7.08E+07	2.92E+08	1.08E+09
Shocked	6.35E+07	2.82E+08	5.88E+08	7.08E+07	3.03E+08	1.04E+09
% Difference	0.08%	5.14%	-5.41%	0.06%	4.45%	-2.97%
Processor Profits						
Base	3.76E+08	2.75E+09	2.18E+09	1.99E+08	1.81E+09	1.58E+09
Shocked	3.77E+08	2.84E+09	2.10E+09	1.99E+08	1.87E+09	1.51E+09
% Difference	0.10%	3.02%	-3.83%	0.09%	3.20%	-4.63%
Consumer Surplus						
Base	6.75	15.48	4.15	9.14	18.04	5.87
Shocked	6.75	15.42	4.20	9.14	17.97	5.94
% Difference	0.00%	-0.46%	1.33%	0.00%	-0.40%	1.16%

Import	**Japan**	**China**	**Russia**	**Japan**	**China**	**Russia**
Country	with market power			without market power		
Import Prices						
Base	199.93	94.24	125.33	90.76	90.76	120.92
Shocked	200.51	94.35	125.45	90.87	90.87	121.04

% Difference	0.29%	0.11%	0.10%	0.11%	0.11%	0.10%
Net Imports						
Base	527619	334882	490260	542196	372405	530078
Shocked	527206	333669	489150	541802	371240	529022
% Difference	-0.09%	-0.54%	-0.47%	-0.08%	-0.41%	-0.35%

Export Country	**Brazil** with market power	**Brazil** without market power
Export Prices		
Base	121.60	106.76
Shocked	122.01	107.16
% Difference	0.34%	0.37%
Net Exports		
Base	576759	500801
Shocked	578773	502714
% Difference	0.38%	0.42%

5.3.2 The EU Chicken Export Subsidy Impact on Consumer Surplus, Processor Profits and Producer Surplus

After the removal of the EU chicken export subsidy, EU producer surplus decreases by 5.41% (MP) and 4.45% (NMP) (Table 5.8-1), and processor profits decrease by 3.83% (MP) and 4.63% (NMP). EU consumer surplus increases by 1.33% (MP) and 1.16% (NMP).

There is an insignificant increase in Canadian chicken processor and processor surplus due to the removal of the EU chicken export subsidies. Canadian consumer welfare remains the same because of the supply management program. For the U.S. market, both chicken producer and processor profits increase after the removal of the EU export subsidies. The above results indicate that EU export subsidies benefit the EU chicken producers and processors, but not consumers, and it has negative effect on both the U.S. and Canadian producer and processor welfare.

5.4 Market Power Effect Implication

Based on the results of this study, oligopoly market power exists in the Canadian, U.S. and EU chicken and turkey industries. This implies that for these industries, few firms provide the majority of the outputs. Usually, firms could produce more under the perfectly competitive market. Oligopoly market power could cause retail price to be higher and farm price to be lower than in the assumed perfectly competitive market, because firms would like to purchase live birds at a lower price level and sell the output at a higher price level. In the oligopoly market model, the wedge between the U.S. chicken retail price and farm price is 114 cents; in the perfectly competitive market this value is 61 cents. The simulation results indicate that with market power this difference is bigger than without market power. The change of the retail and farm prices and the production levels will affect the producer and processor welfare without ambiguity. In the U.S. chicken export subsidy model (Table 5.2-1), simulation results suggest that without the U.S. chicken export subsidy, the U.S. chicken producer surplus will go down by 9.15% if there is oligopoly market power; this value is 6.70% if there is no oligopoly market power. These results suggest that the loss of the U.S. chicken export subsidy will hurt the U.S. chicken producers more in the oligopoly market. For the U.S. chicken processor profits, after the removal of the U.S. chicken export subsidy, the U.S. chicken processor profits go down by 5.78% if there is oligopoly market power; this value is 6.35% if there is no oligopoly market power.

For the U.S. turkey export subsidy model, in the oligopoly market model, the wedge between the U.S. turkey retail price and farm price is 118 cents; in the perfectly competitive market this value is 12 cents. The simulation results indicate that with market

power this difference is bigger than without market power. The simulation results (Table 5.5-1) suggest that without the U.S. turkey export subsidy, the U.S. turkey producer surplus will go down by 4.68% if there is oligopoly market power; this value is 2.27% if there is no oligopoly market power. These results suggest that the loss of the U.S. turkey export subsidy will hurt U.S. turkey producers more in the oligopoly market. For the U.S. turkey processor profits, after the removal of the U.S. turkey export subsidy, the U.S. turkey processor profits will go down by 1.56% if firms have oligopoly power; this value is 0.90% if there is no oligopoly market power. This indicates that the loss of the U.S. turkey export subsidy could reduce processor loss by a lesser amount in the latter model.

For the EU chicken export subsidy model, in the oligopoly market model, the wedge between the EU chicken retail price and farm price is 125 cents; in the perfectly competitive market this value is only 9 cents. The simulation results indicate that with market power this difference is bigger than without market power. The simulation results (Table 5.8-1) suggest that without the EU chicken export subsidy, EU chicken producer surplus will go down by 1.68% if there is oligopoly market power; this value is 1.18% if there is no oligopoly market power. These results suggest that the loss of the EU chicken export subsidy will hurt the EU chicken producers more in the oligopoly market. For the EU chicken processor profits, after the removal of the EU chicken export subsidy, the EU chicken processor profits go down by 3.83% if there is oligopoly market power; this value is 4.63% if there is no oligopoly market power. This indicates that the loss of the EU chicken export subsidy could decrease processor gains more in the later model.

For the Canadian chicken export policy model, in the oligopoly market model, the wedge between the Canadian chicken retail price and farm price is 126 cents; in the

perfectly competitive market this value is 23 cents. The simulation results indicate that with market power this difference is bigger than without market power. The simulation results (Table 5.5-1) suggest that without the Canadian chicken export subsidy, Canadian chicken producer surplus will go down by 4.37% if there is oligopoly market power; this value is 3.92% if there is no oligopoly market power. These results suggest that the loss of the Canadian chicken export policy will hurt Canadian chicken producers more in the oligopoly market. For the Canadian chicken processor profits, after the removal of the policy, Canadian chicken processor profits will go down by 3.70% if there is oligopoly market power; this value is 3.26% if there is no oligopoly market power. This indicates that the loss of the Canadian chicken export policy could hurt processors more in the market power model.

For the Canadian turkey export policy model, in the oligopoly market model, the wedge between the Canadian turkey retail price and farm price is 56 cents; in the perfectly competitive market this value is 8 cents. The simulation results (Table 5.6-1) suggest that without the Canadian turkey export subsidy, Canadian turkey producer surplus falls by 17.78% if there is oligopoly market power; this value is 16.96% if there is no oligopoly market power. These results suggest that the loss of the Canadian turkey export policy will hurt Canadian chicken producers more in the oligopoly market. After the removal of the policy, the Canadian turkey processor profits will go down by 6.53% if there is oligopoly market power; this value is 6.37% if there is no oligopoly market power. This indicates that the loss of the Canadian turkey export policy could hurt processors more in the oligopoly model.

5.5 Summary

This chapter presents the simulation results for the three policy shocks, the U.S. and EU export subsidies and Canadian poultry export policy.

It was shown that the export subsidies from the U.S. have a positive effect on the U.S. chicken and turkey producer surplus, but negative effects on EU, and Canadian poultry producer surplus. These results are not surprising, because the export subsidies from the U.S. should decrease the retail, import or export prices in the other countries.

In comparison to the U.S. export subsidies, EU chicken export subsidies impact the international market in a similar fashion. This policy has positive effects on EU producer surplus and processor profits, but not consumer surplus. The U.S. and Canadian producers and processors have negative impacts from these policies.

In comparison to the U.S. export subsidies, the Canadian poultry export policy shocks also impact the international market significantly. Contrary to the U.S. export subsidies, the Canadian poultry export policies do not change the domestic retail price and retail demand because of the supply management program. However, these policy shocks reduce the retail, import and export prices of the other countries, and benefit the Canadian chicken and turkey producers and processors. They also have certain negative effects on other trade countries' (U.S. and EU) producer and processor welfares.

The trade model in the current study also allows for the simulation conducted under both the perfectly competitive market and oligopoly market. The changes due to the policy shocks on the two models are very similar. The results suggest that Canadian chicken and turkey producer and processor surpluses increase more under the perfectly competitive than under the oligopoly market with the poultry export policies. With the

U.S. export subsidy shock, the U.S. chicken producers gain more under the oligopoly market than under the perfectly competitive market; the U.S. chicken and turkey processors, producers gain more under the perfectly competitive market.

Both the current results and the previous studies (*Alston, 1985; Alston, and Scobie 1987; Haley, 1990)* suggested that the poultry export subsidies (or export policies for Canada) from one country can help the country increase its exports, and benefit its own producers and processors. They also reduce other competitors' international market shares and cause the international trade price to fall.

The current study discussed the relationships between policy simulations across products. The U.S. chicken (turkey) export subsidy impacts on turkey (chicken) market were examined. And Canadian chicken (turkey) export policy impacts on turkey (chicken) market were examined as well. These simulations were conducted based on the relationship of the retail demand equations of both products. As such, one can raise the concern of how a trade policy's impact on one product could affect its substitute product markets as well.

CHAPTER 6

SUMMARY, CONCLUSIONS AND LIMITATIONS

In this chapter, the objectives, research results, limitations and avenues for future studies will be discussed. The objectives will be discussed first, followed by the conclusions and the limitations of this study. Finally, areas of further research are presented.

6.1 Summary, Conclusions, and Discussion

The general aim of this dissertation is to estimate a model of poultry trade for Canada, the U.S., EU and other main poultry importers and exporters. In doing so, the impacts of the different trade or domestic policies on the Canadian and other countries' poultry market and the welfare changes caused by the trade flows need to be examined.

In Chapter 1, Canadian chicken and turkey industry information was discussed and the objectives of the study were developed. The background of the domestic and trade policies related to Canadian poultry trade were presented. The main poultry trading countries and Canada's competitors were also chosen.

In Chapter 2, previous studies and economic theory were combined to develop a method to specify the model for this study. The main poultry trade importers and exporters were chosen. Consumer and firm theories based on previous studies' were presented and discussed. The major poultry trading countries' policies and possible market structures were also discussed.

The poultry industry structures of Canada, the U.S. and EU were discussed in Chapter 2. Based on this discussion, the three countries' regional models were established

in Chapter 3. Canadian chicken and turkey models were specified taking into account the existence of the Supply Management Program and oligopoly market power. The U.S. and EU models were specified only with the concern of oligopoly market power. For the other main trading countries, only the export supply or import demand equations were estimated. The data information and the estimation methodology were presented in Chapter 3 as well. All data were discussed with the poultry industry information in that country. The information of this chapter gives an idea of the status of these countries' poultry production, consumption, prices, and trade. Also, the estimation methodologies were introduced.

In Chapter 4, the model developed in Chapter 2 was estimated. The demand and supply equations were specified and discussed first. Then the estimation results were presented. The current and previous retail demand, supply and input elasticities were also compared. The model validation statistics were introduced, and the model validation results were presented.

The results of various policy shocks on the base model were presented in Chapter 5. The effects on Canadian and international markets were presented and discussed.

The objectives stated in Chapter 1 are presented below, followed by the results and conclusions for each objective.

Objective 1: Estimate and simulate a partial equilibrium model of the international poultry meat market with the assumption that poultry meat is homogeneous products

This objective was accomplished in Chapter 3 and 4. The theoretical model was established based on different countries' market structures. Among them, the Canadian

model was established under the scenario of oligopoly market power and the supply management program; the U.S. and EU models were specified based on oligopoly market power structures. In each regional model, retail demand, farm supply, producer demand, and market power equations were estimated. For other trading countries, data limitations make it difficult to estimate the industries with two market levels, so only the import demand and export supply equations were specified.

Objective 2: Evaluate the impacts of the different regional policies on Canadian poultry exports with a simulation approach.

This objective was accomplished in Chapter 5. Based on the regression results of the regional models, policy simulations were conducted and results were explained. The U.S. and EU export subsidies, and Canadian poultry export policies have impacts on Canadian domestic and international poultry markets. The conclusions based on these results will be presented in the following section.

Objective 3: Analyze the impacts of trade policy changes on welfare for Canadian consumers, processors, and farmers

This objective was accomplished in Chapters 2, 3, and 5. In Chapter 2, the concepts of the consumer welfare and producer welfare were introduced. Chapter 3 included the discussion of the methodology of the calculation. The consumer and producer welfare change due to the poultry trade policies of each country's poultry industry in this study were presented and discussed in Chapter 5.

6.2 Conclusions

6.2.1 The U.S. Export Subsidies

Canadian imports from the rest of the world are assumed to be exogenous. U.S. export subsidy changes the amount of exports, export prices and the producer surplus and processor profits of the Canadian poultry industry. The U.S. export subsidy caused Canadian chicken processor profits to decrease by 2.62%, and turkey processor surplus decreased by 2.03% when the industry is under the oligopoly market power. Under the assumption of a perfectly competitive market, the two values are 2.96% and 1.81%. The export subsidies from the U.S. also decrease the international poultry trade prices; the export prices of Canadian chicken and turkey exports dropped 22.67% and 15.14% with market power, and dropped by 27.67% and 15.14% under the assumption of a perfectly competitive market due to this change.

The export subsidies from the U.S. have a significant impact on its competitors like the EU. Under the market power scenario, the EU chicken exports price decreased by 23.65% and 29.26% under oligopoly and perfectly competitive markets. For Brazil, the total chicken and turkey export quantities decreased by 16.34% and 18.85% due to the drop of the international price.

The main poultry importers, like Japan, Russia, and China, increased their chicken and turkey exports because they can get more competitive market prices from the main poultry exporters. These changes based on the U.S. export subsidy shock are very similar under a perfectly competitive market. However, the results indicate that under a perfectly competitive market, producers in all the main exporters would like to produce

more poultry products. The international trade prices and trade flows were shocked by the policies with more sensitivity compared to the market with market power.

The U.S. processors and producers benefited from their export subsidies. The policy simulation results suggest that the U.S. chicken and turkey producer surplus increased by 9.15% and 4.68% if there is market power. Under a perfectly competitive market, the U.S. chicken and turkey producer surplus increased by 6.70% and 2.27%. However, under both market structures, U.S. retail prices increased and domestic demand decreased; therefore consumer surplus decreased. This indicates that only the producers gained from the export subsidies, not the consumers.

The U.S. chicken export subsidy has cross effects on the turkey market, so the turkey processors and producers in Canada and EU are affected by this policy. The simulation results suggest that under both market structures, the U.S. chicken export subsidy could increase its turkey exports as well. However, it could also lower the domestic turkey consumption. With this policy, the U.S. turkey processor profits decreased by 0.20% (MP) and 0.23% (NMP). The U.S. turkey producer surplus decreased by 0.60% (MP) and 0.51% (NMP).

The U.S. turkey export subsidy has cross effects on the chicken market. The simulation results suggest that turkey processors and producers in Canada and the EU are affected by this policy. Under both market structures, the U.S. turkey export subsidy could lower its chicken exports. It could also increase the domestic chicken supply. The U.S. turkey export subsidy caused the U.S. chicken processor profits to increase by 0.14% (MP) and 0.65% (NMP) and the U.S. chicken producer surplus increased by

0.27% (MP) and 1.16% (NMP). Canadian chicken processor profits increased by 0.006% (MP) and 0.033% (NMP).

The simulation results in this study are consistent with results of previous studies. *Haley (1990)* found that in 1987, the U.S. poultry exports increased 790,000 metric tons due to EEP. The U.S. poultry prices have increased about 1.2% to 5.3% (in the current study this value is 4.11%). In Haley's study, he also concluded that the small producer gains (98 million dollars) due to the program having been matched by equivalent consumer losses (96 million dollars).

6.2.2 Canadian Export Policies

As presented in Chapter 5, Canada's export policies increase Canada's chicken and turkey total exports. The simulation results indicate that Canada's poultry export policies can benefit the Canadian chicken and turkey producers significantly. With market power, Canadian chicken producer surplus increased by 4.37%, and turkey producer surplus increased by 7.78%. Without market power, Canadian chicken producer surplus increased by 3.92%, and turkey producer surplus increased by 16.96%. The Canadian chicken processor profits increased by 3.70% (MP) and 3.26% (NMP). The Canadian turkey processor profits increased by 6.53% (MP) and 6.37% (NMP). The Canadian consumer surplus did not change due to the static retail demand and retail price under supply management.

Canada's poultry export policies decrease the producer surplus of the U.S, where chicken producer surplus dropped by 1.08% (MP) and 0.96% (NMP) respectively; the U.S. turkey producer surplus dropped by 0.79% (MP) and 1.26% (NMP). The U.S.

chicken processor profits drop by 0.51% (MP) and 0.58% (NMP). The U.S. turkey processor profits dropped by 0.29% (MP) and 0.30% (NMP). Brazil and the EU both decreased their export prices and quantities.

In general, the Canadian poultry export policies has expanded the volume of the Canadian poultry exports, to the extent that export competitors' benefits are worse off.

The Canadian chicken export policy has cross effects on the turkey market. The simulation results suggest that under both market structures, the Canadian chicken export policy could increase its turkey export price. It could also increase the Canadian turkey processor profits. Canadian turkey processor profits increased by 3.88% (MP) and 3.64% (NMP). Due to this policy shock, the U.S. turkey producer surplus increased by 0.06% (MP) and 0.02% (NMP). The U.S. turkey processor profits increased by 0.02% (MP) and 0.008% (NMP). With this chicken export policy shock, all the other main turkey exporters (EU and Brazil) decrease the net export volumes because of the lower export prices. The main turkey importers (Russia and Mexico) increased their net imports.

The Canadian turkey export policy has cross effects on the chicken market. The simulation results suggest that under both market structures, the Canadian turkey export policy could lower its chicken export price. Canadian chicken processor profits decreased by 0.0039% (MP) and 0.0033% (NMP). With this policy shock, the U.S. chicken net export could decrease by 0.03% (MP) and 0.02% (NMP). The U.S. chicken producer surplus could decrease by 0.15% (MP) and 0.17% (NMP). All the other main chicken exporters (Brazil) decrease their net export volumes because of the lower export prices. The main chicken importers (Russia, Russia, and Japan) could increase the net imports.

6.2.3 The EU Export Subsidies

The simulation results show that the EU chicken export subsidy could benefit the EU producers and processors. The EU producer surplus increased by 5.41% (MP) and 2.97% (NMP). The EU processor profits increased by 3.83% (MP) and 4.63% (NMP). EU consumer surplus decreased by 1.33% (MP) and 1.16% (NMP).

Similar to the U.S. export subsidy, the EU net exports lowers the international poultry trade prices. The main chicken exporters such as the U.S. and Brazil could lower their exports. The main chicken importers would like to expand their imports because of the better import prices.

Previous studies by *Alston and Scobie (1987)* found similar results. Their findings suggest that with the EU poultry export subsidy, the EU's export price increases by 1.5% (1.52% in this thesis). The EU's exports increase by 75% (13.69% in this thesis).

6.3 Limitations

There are a number of limitations to this study. First, it is assumed that the U.S. and EU poultry processors only possess oligopoly power. However, they also could possess oligopsony power.

Second, in this study chicken (turkey) is assumed to be homogeneous products. This assumption means all the chicken (turkey) products from all the countries are the same. However, previous studies suggest that poultry products are differentiated by country of origin as well as by attributes of the products. Like some Asian countries, consumers prefer dark meat to white meat. Assuming that chicken (turkey) is homogeneous products has the potential to alter the results.

Another limitation is that the sample used to estimate the econometric model is small. For Canada, the U.S., and EU regional model, 25 years of data was estimated. However, in the large trade model, only 12 years of data were estimated because there is not enough data.

One final limitation is that the model is estimated using annual data, so any seasonal variation is lost. Furthermore, with annual data, a longer period of estimation is needed to get better regression results, and some of the historical data may not be available.

6.4 Further Research

Based on the limitations above, several areas of future work are evident. First, attempts should be made to incorporate oligopsony power into the current model. The oligopsony power may give more appropriate estimation results of the model. As well, attempts should be made to differentiate chicken (turkey) by type as well as by country of origin. Attempts are also needed to gather more data: quarterly data could make seasonal variation evident; alternatively, a longer data period could give the robust regression and simulation results.

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APPENDIX A: Definition of Endogenous Variables

Endogenous Variable	Definition	Source	Units
CARDCK	Per capita Canadian chicken consumption	USDA	kg
CARPCK	Canadian chicken retail price	AAFC	$/kg
CAPDCK	Canadian chicken producer demand	USDA	Kg
CAQV	Canadian chicken farm quota value	CFC	$/kg
CAFMC	Canadian chicken farm marginal cost	AAFC	$/kg
CARSCK	Canadian chicken retail supply	USDA	Kg
CAEXP	Canadian chicken export price	FAO	$/kg
USRDCK	U.S. Per capita chicken retail consumption	USDA	Kg
USRPCK	U.S. chicken retail price	USDA	$/kg
USPDCK	U.S. chicken producer demand	USDA	Kg
USFPCK	U.S. chicken farm quota value	USDA	$/kg
USRSCK	U.S. chicken retail supply	USDA	Kg
USTRADE	U.S. chicken net exports	USDA	Kg
EURDCK	EU Per capita chicken retail consumption	USDA	Kg
EURPCK	EU chicken retail price	DSI &.EUFP	$/kg
EUPDCK	EU chicken producer demand	USDA	Kg
EUFPCK	EU chicken farm price	EC	$/kg
EUTRADE	EU chicken net exports	USDA	Kg
EURSCK	EU chicken retail supply	USDA	Kg
RUIMP	Russian chicken import price	FAO & USDA	$/kg
RUTRADE	Russian chicken net imports	FAO & USDA	Kg
JAIMP	Japan chicken import price	FAO & USDA	$/kg
JATRADE	Japan chicken net imports	FAO & USDA	Kg
CHIMP	China chicken import price	FAO & USDA	$/kg
CHTRADE	China chicken net imports	FAO & USDA	Kg
BREXP	Brazil chicken export price	FAO & USDA	$/kg
BREX11	Brazil chicken net exports	FAO & USDA	Kg
TCARDCK	Canadian turkey per capita consumption	USDA	Kg
CARPTUR	Canadian turkey retail price	AAFC	$/kg
TCAFSCK	Canadian turkey farm supply	USDA	Kg
TCAQV1	Canadian turkey farm quota value	CTMA	$/kg
TCAFMC	Canadian turkey farm marginal cost	AAFC	$/kg
TCARSCK	Canadian turkey retail supply	USDA	Kg
TCAEXP	Canadian turkey export price	Stat-Canada	$/kg
TRDCK	U.S. turkey per capita consumption	USDA	Kg
RPTUR	U.S. turkey retail price	USDA	$/Kg
TPDCK	U.S. turkey producer demand	USDA	Kg
TFPCK	U.S. turkey farm price	USDA	$/kg
TRSCK	U.S. turkey retail supply	USDA	Kg
USTTRADE	U.S. turkey net exports	USDA	Kg
TRUIMP	Russian turkey import price	FAO & USDA	$/kg
TRUTRADE	Russian turkey net imports	FAO & USDA	kg
TBREMP	Brazil turkey import price	FAO & USDA	$/kg

TBRTRADE	Brazil turkey net imports	FAO & USDA	kg
TEUEMP	EU turkey export price	FAO & USDA	$/kg
TEUTRADE	EU turkey net exports	FAO & USDA	kg
TMAIMP	Mexico turkey import price	FAO & USDA	$/kg
TMATRADE	Mexico turkey net imports	FAO & USDA	kg

APPENDIX B: Definition of Exogenous Variables

Exogenous Variable	Definition	Source	Units
CARPBF	Canadian beef retail price	AAFC	$/kg
CARPPK	Canadian pork retail price	AAFC	$/kg
CAPDI	Canadian per capita income	USDA	1000$
CAFIP	Canadian chicken farm input price (feed cost)	AAFC	$/kg
CAEX	Canadian chicken export quantity	AAFC	MT
CAIM	Canadian chicken import quantity	USDA	MT
CANF	Number of Canadian chicken processor firms	Stat-Canada	Number
CAW1	Canadian farm input prices (feed cost)	Stat-Canada	Cents/kg
CAW2	Canadian processor input prices (wage rate)	Stat-Canada	$/hour
CAW3	Canadian processor input prices (electricity)	AAFC	$/hour
CAPOP	Canadian population	USDA	000'
CAER	Canadian exchange rate	USDA	US base
USRPBF	U.S. beef retail price	USDA	$/kg
USRPPK	U.S. pork retail price	USDA	$/kg
USPDI	U.S. per capita income	USDA	1000$
USEX	U.S. chicken export quantity	USDA	MT
USIM	U.S. chicken import quantity	USDA	MT
USNF	U.S. chicken processor firm concentration ratio	LRD	Percent
USW1	U.S. chicken farm input prices (feed cost)	USDA	$/kg
USW2	U.S. processor input prices (wage rate)	USDA	$/kg
USW3	U.S. processor input prices (electricity)	USDA	$/kg
USPOP	US population	USDA	000'
EURPBF	EU beef retail price	EUFP&DSI	$/kg
EURPPK	EU pork retail price	EUFP&DSI	$/kg
EUPDI	EU per capita income	USDA	1000$
EUEX	EU export quantity	USDA	MT
EUIM	EU import quantity	USDA	MT
EUNF	Number of EU chicken processor firms	EC	Number
EUW1	EU farm input prices (feed cost)	EC	Cents/kg
EUW2	EU processor input prices (wage rate)	EC	$/hour
EUW3	EU processor input prices (electricity)	EC	$/hour
EUPOP	EU population	USDA	000'
EUER	EU exchange rate	USDA	US base
TCAFIP	Canadian turkey farm input price (feed cost)	AAFC	$/kg

TCAEX	Canadian turkey export quantity	AAFC	MT
TCAIM	Canadian turkey import quantity	USDA	MT
TCANF	Number of Canadian turkey processor firms	Stat-Canada	Number
TCAW1	Canadian turkey farm input prices (feed cost)	Stat-Canada	Cents/kg
TCAW2	Canadian processor input prices (wage rate)	Stat-Canada	$/hour
TCAW3	Canadian processor input prices (electricity)	AAFC	$/hour
TUSEX	U.S. turkey export quantity	USDA	MT
TUSIM	U.S. turkey import quantity	USDA	MT
TUSNF	U.S. turkey processor firms' concentration ratio	LRD	Percent
TUSW1	U.S. turkey farm input prices (feed cost)	USDA	$/kg
TUSW2	U.S. processor input prices (wage rate)	USDA	$/kg
TUSW3	U.S. processor input prices (electricity)	USDA	$/kg
RUCON	Russian chicken consumption	USDA	MT
RUCPI	Russian Consumer Price Index	USDA	00 base
CHPDI	Chinese Per capita Income	USDA	000$
CHPD	Chinese chicken production	USDA	MT
CHTRF	Chinese meat tariff rate change	USDA	Percent
CHER	Chinese exchange rate	USDA	US base
JAPDI	Japanese Per capita Income	USDA	000$
JAPD	Japanese chicken production	USDA	MT
JATRF	Japanese meat tariff rate change	USDA	Percent
JAER	Japanese exchange rate	USDA	US base
BRPDI	Brazilian Per capita Income	USDA	000$
BRPD	Brazilian chicken production	USDA	MT
BRTRF	Brazilian meat tariff rate change	USDA	Percent
BRER	Brazilian exchange rate	USDA	US base
MEPDI	Mexican Per capita Income	USDA	000$
MEPD	Mexican turkey production	USDA	MT
METRF	Mexican meat tariff rate change	USDA	Percent
MEER	Mexican exchange rate	USDA	US base
TEUPDI	EU Per capita Income	USDA	000$
TEUPD	EU turkey production	USDA	MT
EUER	EU exchange rate	USDA	US base
TBRPD	Brazilian turkey production	USDA	MT
USES	U.S. export subsidies	USDA	$/kg
EUES	EU export subsidies	USDA	$/kg
ROWTRADE	Rest of world chicken trade	USDA	MT
TROWTRADE	Rest of world turkey trade	USDA	MT

(USDA: United States Department of Agriculture; AAFC: Agriculture and Agri-food Canada; Stat-Canada: Statistics Canada; CFC: Chicken Farmers of Canada; FAO: Food and Agriculture Organization; EUFP: European Union Financial Publication; DSI: OECD Statistical Compendium; EC: European Commission, Agriculture Statistical Year Book; CTMA: Canadian Turkey Marketing Agency; LRD: Longitudinal Research Database)

APPENDIX C Trade Theory

In this section, an overview of the basic relationship between trade and trade policies is provided. Trade policy mechanisms, such as tariffs and import quotas, export subsidies and domestic support policies are presented.

With each passing year, the national economies of the world become more and more closely integrated due to international trade liberations around the globe and for most individual countries. The economics of trade and trade policy grow increasingly important for people concerned about commercial affairs.

C.1 Basic Trade Theory

Houck (1986) introduced the basic trade model in his book, *Elements of Agricultural Trade Policies,* with a three-panel trade diagram. The model is based on following assumptions:

. The commodity is homogeneous

. There is only one market level

. Only two countries trading

. No transportation costs

. Perfect competition

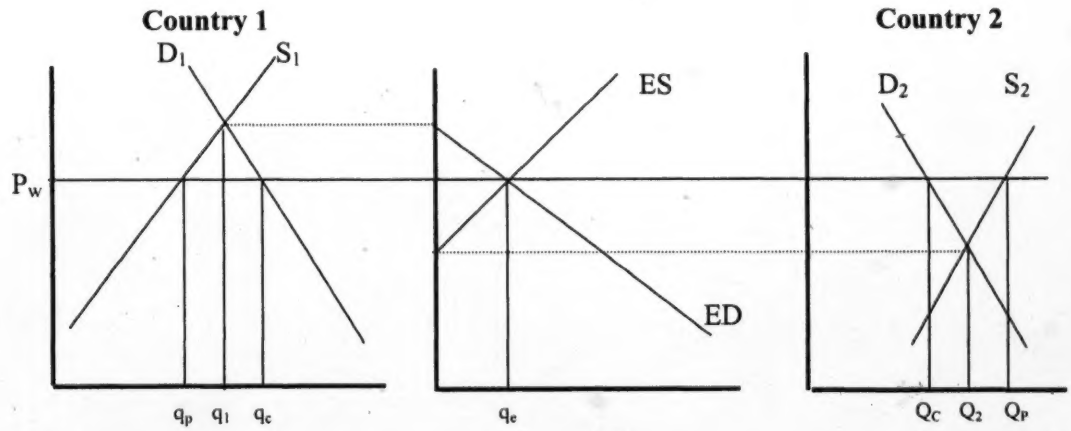
. No government intervention

. Under same currency

A partial equilibrium model is used to present the basic trade theory. In a two-country one-commodity world, country 1 has excess demand and country 2 has excess supply. Where transfer costs are assumed to be zero, equilibrium exists where the excess

supply of county 1 is equal to the excess demand of country 2. This equilibrium is illustrated in Figure 2.2.

Figure C.1 Three Panel Trade Diagram



As compared to autarky, with trade, domestic price in country 1 will decrease and price in country 2 will decrease until the equilibrium price P_w is reached. Also, country 1 increases its consumption to q_c and lowers its production to q_p. Country 2 increases its production from Q_2 to Q_p and consumption drops from Q_2 to Q_C.

However, the assumptions for the model are unrealistically strict. Any change on these assumptions may change the outcomes of trade. For international poultry trade, some of the above assumptions are violated. In the following section, the main forms of government intervention in the poultry industry, tariffs, import quotas, and export subsidies will be discussed. These analyses follow the presentation of Houck (1986).

C.2 Tariff and Quotas

Tariffs are the most common form of protective trade policy. An import tariff is a tax levied on the importation of foreign goods. Now let us consider briefly the economic consequences that emerge if country 1 levies a tariff in the international market.

Figure C.2 Three Panel Diagram with a Tariff

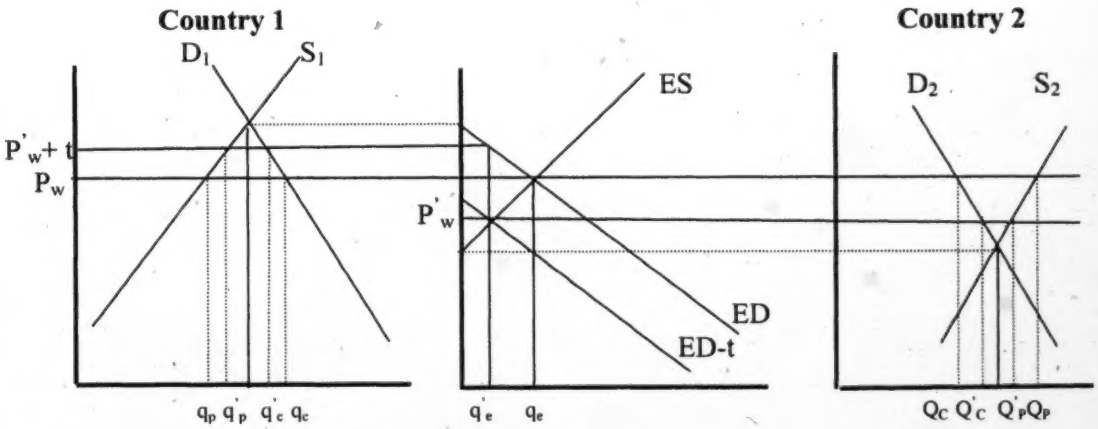
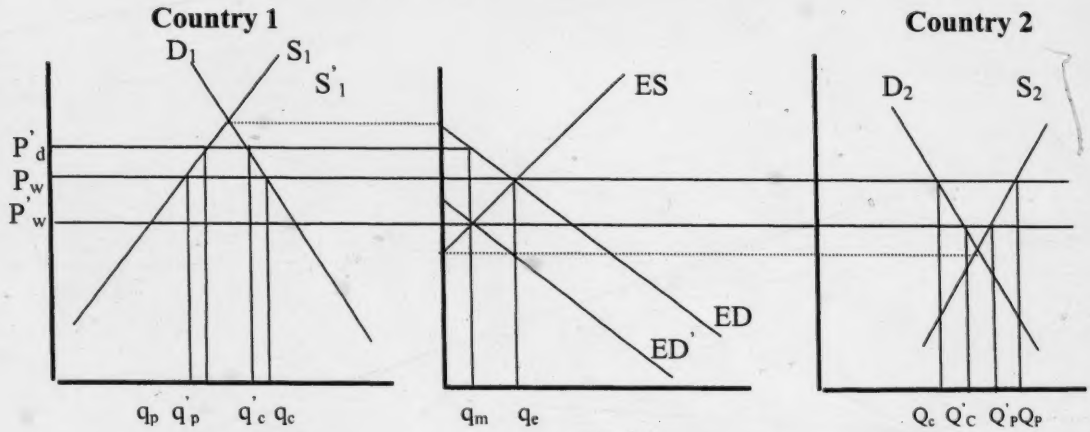


Figure 2.3 shows a three panel trade diagram with a tariff. The free trade equilibrium price level was equal to P_w without any trade intervention. The import tariff lowers the excess demand curve for imports to ED-t. This makes the world price move to P'_w. The domestic price in country 1 increases to P'_w+t. Therefore, the exports in country 2 shrink from Q_p-Q_c to Q'_p-Q'_c, and the imports of country 1 decrease from q_c-q_p to q'_c-q'_p.

As discussed above, tariffs allow the import country to import as little as they wish. The tariff directly affects the price of imports and indirectly affects the quantity of imports via the effect of price increases on consumer and producer decisions. Usually, the tariff revenue is received by the importing countries.

After tariffs, the second most common form of trade restriction is an important quota. Quotas are ceiling on the quantities of imports (Markusen, 1984). Overall, the effects of a quota are similar to those of a tariff---internal prices rise, domestic production expands, domestic use declines and world prices and imports fall. But there is one import difference: a quota is an absolute number whereas a tariff is relative. The effect of an import quota q_m is depicted in Figure 2.4.

Figure C.3 Three Panel Diagram with a Quota



International markets are initially assumed to be in equilibrium at world price P_w and imports q_e to country 1. After imposing an import quota q_m the original excess demand curve ED becomes ED'. Therefore the internal price of country 1 becomes to P'_d. At any international price below price P'_d, the amount q_m is imported by country 1. The international price falls to P'_w which is determined by the intersection of ES and ED'. The function of the quota is similar to a tariff, however, the quota is the absolute value, and tariff is the percentage value.

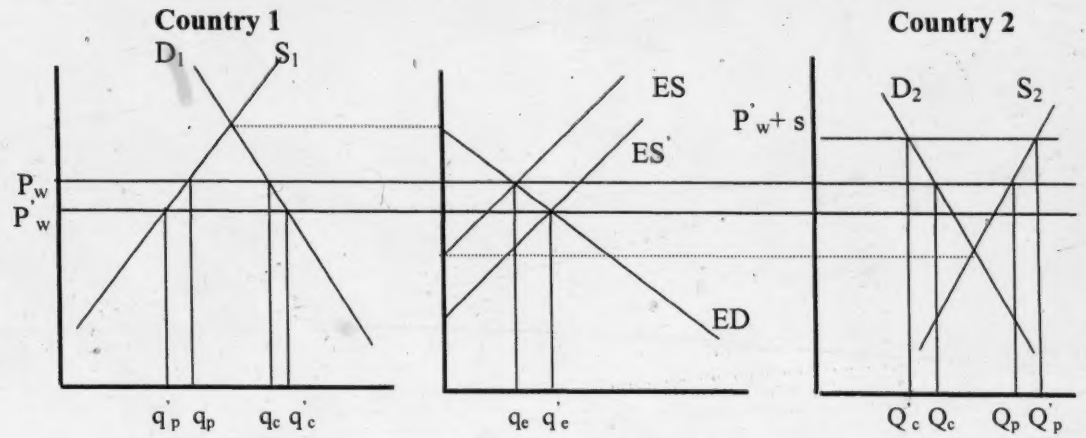
C.3 Export Subsidy

Export subsidies occur when the government pays an exporter to aid its exports. Such a payment enables an export firm to purchase the product internally at a higher price and sell it externally at a lower price. Figure 2.5 shows a three panel trade diagram with an export subsidy.

The world price before the export subsidy is at P_w. Country 2 imposed an export subsidy, causing the excess supply curve shift to ES'. This results in a new equilibrium between excess supply curve and excess demand curve at P'_w. At P'_w, the quantity demanded in Country 1 will increase from q_c-q_p to the level of q'_c-q'_p. This change

enables the supply in country 2 expand from Q_P-Q_C to Q'_P-Q'_C. Then the domestic price in country 2 increases to P'_w+s. The export subsidy reduces world price, expands exports of export countries, and expands imports of import countries.

Figure C.4 Three Panel Diagram with an Export Subsidy

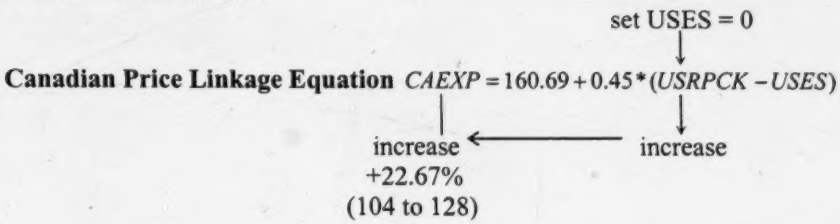


Appendix D Algebraic Discussion of the Simulation

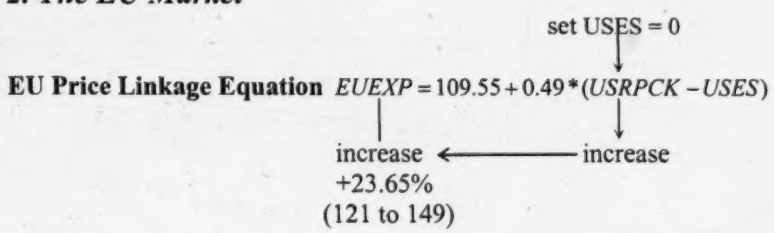
D.1 Algebraic Discussion of the Simulation Results, Removal of the U.S. Export Subsidy Impact on International Chicken Market ---- Based on the Results of Table 5.2-1

Under Oligopoly Market Power Market

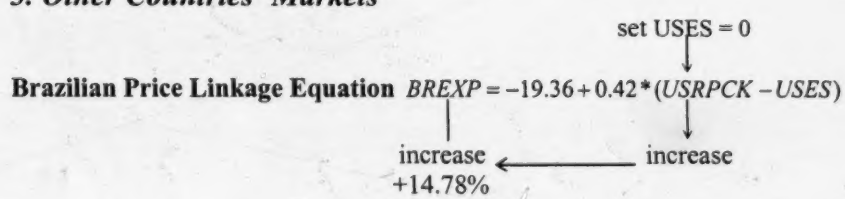
1. Canadian Market

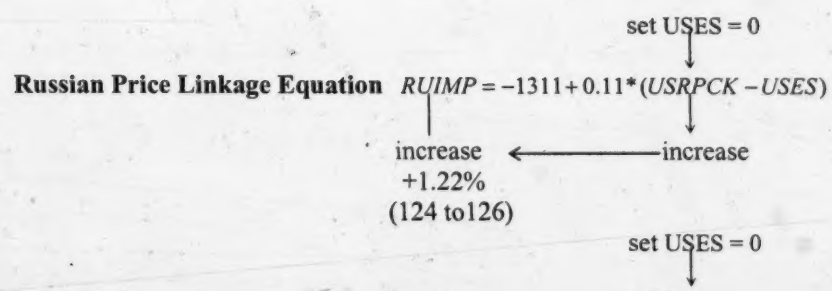


2. The EU Market



3. Other Countries' Markets





Japanese Price Linkage Equation $JAIMP = -259 + 0.93 * (USRPCK - USES)$

increase ← increase

+41.61%

(201 to 283)

set USES = 0

Chinese Price Linkage Equation $CHIMP = -51.54 + 0.82 * (USRPCK - USES)$

increase ← increase

+6%

(93 to 97)

Under Assumed Perfect Competitive Market

1. Canadian Market

set USES = 0

Canadian Price Linkage Equation $CAEXP = 160.69 + 0.45 * (USRPCK - USES)$

increase ← increase

+27.67%

(85 to 109)

2. The EU Market

set USES = 0

EU Price Linkage Equation $EUEXP = 109.55 + 0.49 * (USRPCK - USES)$

increase ← increase

+29.26%

(98 to 126)

3. Other Countries' Markets

set USES = 0

Brazilian Price Linkage Equation $BREXP = -19.36 + 0.42 * (USRPCK - USES)$

increase ← increase

+16.79%

(105 to 123)

set USES = 0

Russian Price Linkage Equation $RUIMP = -1311 + 0.11 * (USRPCK - USES)$

increase ← increase

+1.23%

(123 to124)

set USES = 0

Japanese Price Linkage Equation $JAIMP = -259 + 0.93 * (USRPCK - USES)$

increase ← increase

+63.34%

(134 to 216)

set USES = 0

Chinese Price Linkage Equation $CHIMP = -51.54 + 0.82 * (USRPCK - USES)$

increase ← increase

+6.32%

(88 to 94)

D.2 Algebraic Discussion of the Simulation Results, Removal of the Canadian Export Policy Impact on International Chicken Market ---- Based on the Results of Table 5.5-1

Under Oligopoly Market Power Market

1. Canadian Market

Canadian Trade Identity

$CAPDCK = CARDCK * CAPOP + CAEX - CAIM$

-3.75% ← drop to zero; no change

(1944407 to 1864244)

2. The U.S. Market

Trade Identity $ROWTRADE = (CAEX - CAIM) + USTRADE + net\ trade\ of\ other\ countries$

drop to zero → increase

3. The EU Market

Trade Identity $ROWTRADE = (CAEX - CAIM) + EUTRADE + net\ \ trade\ \ of\ \ other\ \ countries$

drop to zero ⟶ increase

4. Other Countries' Trade Identities:

$ROWTRADE = USTRADE + (CAEX - CAIM) + EUTRADE + BRTRADE$

+1.45% (1542391 to 1571014); drop to zero; +0.09% (427730 to 428152); +0.08% (569326 to 569801)

$- JATRADE - CHTRADE - RUTRADE$

-0.05% (526782 to 526510); -0.06% (340598 to 340371); -0.01% (496008 to 495945)

Under Perfect Competitive Market Structure

1. Canadian Market

Canadian Trade Identity

$CAPDCK = CARDCK * CAPOP + CAEX - CAIM$

-3.33% (2232096 to 2151935) ⟵ drop to zero; no change

(65 to 62); (1.89 to 4.27)

2. The U.S. Market

Trade Identity $ROWTRADE = (CAEX - CAIM) + USTRADE + net\ \ trade\ \ of\ \ other\ \ countries$

drop to zero ⟶ increase

3. The EU Market

Trade Identity $ROWTRADE = (CAEX - CAIM) + EUTRADE + net\ \ trade\ \ of\ \ other\ \ countries$

drop to zero ⟶ increase

4. Other Countries' Trade Identities:

$$ROWTRADE = USTRADE + (CAEX - CAIM) + EUTRADE + BRTRADE$$

$USTRADE$	$(CAEX - CAIM)$	$EUTRADE$	$BRTRADE$
+1.32%	drop to zero	+0.10%	+0.09%
(1726362 to 1754892)		(426372 to 426821)	(496059 to 496565)

$$- JATRADE - CHTRADE - RUTRADE$$

$JATRADE$	$CHTRADE$	$RUTRADE$
-0.05%	-0.06%	-0.01%
(574512 to 574223)	(392337 to 392096)	(505885 to 505817)

** The first value in the brackets is the average simulated value from the base model; the second is the average simulated value from the shocked model.